PHILOSOPHICAL

TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

LONDON.

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FOR THE YEAR MDCCCXLIII.

PART I.

LONDON:
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MDCCCXLIII.

ADVERTISEMENT.

The Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions,* take this opportunity to acquaint the Public, that it fully appears, as well from the Council-books and Journals of the Society, as from repeated declarations which have been made in several former *Transactions,* that the printing of them was always, from time to time, the single act of the respective Secretaries till the Forty-seventh Volume; the Society, as a Body, never interesting themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued, for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

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But the Society being of late years greatly enlarged, and their communications more numerous, it was thought advisable that a Committee of their members should be appointed, to reconsider the papers read before them, and select out of them such as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March 1752. And the grounds of their choice are, and will continue to be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgement of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a Body,

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upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the Chair, to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they received them, are to be considered in no other light than as a matter of civility, in return for the respect shown to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society; the authors whereof, or those who exhibit them, frequently take the liberty to report and even to certify in the public newspapers, that they have met with the highest applause and approbation. And therefore it is hoped that no regard will hereafter be paid to such reports and public notices; which in some instances have been too lightly credited, to the dishonour of the Society.

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HER MAJESTY QUEEN VICTORIA, in restoring the Foundation of the Royal Medals, has been graciously pleased to approve of the following regulations for the award of them:

That the Royal Medals be given for such papers only as have been presented to the Royal Society, and inserted in their Transactions.

That the triennial Cycle of subjects be the same as that hitherto in operation: viz.

1. Astronomy; Physiology, including the Natural History of Organized Beings.
2. Physics; Geology or Mineralogy.
3. Mathematics; Chemistry.

That, in case no paper, coming within these stipulations, should be considered deserving of the Royal Medal, in any given year, the Council have the power of awarding such Medal to the author of any other paper on either of the several subjects forming the Cycle, that may have been presented to the Society and inserted in their Transactions; preference being given to the subjects of the year immediately preceding: the award being, in such case, subject to the approbation of Her Majesty.

The Council propose to give one of the Royal Medals in the year 1843 for the most important unpublished paper in Physics, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1840, and prior to the termination of the Session in June 1843.

The Council propose also to give one of the Royal Medals in the year 1843 for the most important unpublished paper in Geology or Mineralogy, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1840, and prior to the termination of the Session in June 1843.

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The Council propose also to give one of the Royal Medals in the year 1845 for the most important unpublished paper in Physiology, including the Natural History of Organized Beings, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1842, and prior to the termination of the Session in June 1845.

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The Council propose also to give one of the Royal Medals in the year 1846 for the most important unpublished paper in Geology or Mineralogy, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1843, and prior to the termination of the Session in June 1846.

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PHILOSOPHICAL TRANSACTIONS.

I. *On certain improvements on Photographic Processes described in a former Communication, and on the Parathermic Rays of the Solar Spectrum. By Sir* J. F. W. Herschel, *Bart., K.H., F.R.S., &c.; in a Letter addressed to* S. Hunter Christie *Esq., Sec. R.S. Communicated by* S. Hunter Christie.

Received November 17,—Read November 17, 1842.

Dear Sir,

231. I BEG leave herewith to submit for your inspection and that of the Royal Society, a series of photographic impressions illustrative of the chrysotype, cyanotype, and other processes, an account of which is given in the Postscript to my last paper on that subject, which has, by permission of the President and Council, been appended to the original in its printed form subsequently to the termination of the Session. In the interval which has since elapsed, besides the discovery of other photographic novelties (which may form the subject of future communications), I have been enabled materially to improve some of the processes there described; and these improvements, with a few remarks on some other points treated of in that paper, in relation to the processes in which the thermic rays are concerned, are now subjoined.

232. The positive cyanotype process described in Arts. 219, 220 of my papers, though beautiful in its effect (especially during the first few minutes of the appearance of the picture), is very precarious in its ultimate success, owing to causes there detailed. The remedies proposed are also only occasionally and partially successful, and in consequence this process, though exceedingly *easy* in its manipulations, could not be recommended as practically useful. After trying a vast variety of means to overcome these obstacles to its success, I have succeeded at last, by the simple addition of corrosive sublimate to the ammonio-citrate of iron with which the paper is prepared. The improved process, therefore, may be thus stated. Mix together equal measures of a saturated cold solution of corrosive sublimate, and a solution of am-

monio-citrate of iron, one part by weight of the salt to eleven parts water. No immediate precipitation takes place, and before any has time to do so, the mixture must be washed over paper (which should have rather a yellowish than a bluish cast), and dried. It is now ready for use, and I do not find that it is impaired by keeping. To use it, it must be exposed to the light till a faint, but yet perfectly visible picture is impressed, and till the border (if it be an engraving which is copied) has assumed a pale brown colour. Being withdrawn it is to be brushed over as rapidly as possible with a broad flat brush, dipped in a saturated solution of prussiate (ferrocyanate) of potash diluted with three times its bulk of gum-water, so strong as just to flow freely without adhesion to the lip of the vessel. All the care that is required is, that the film of liquid be very thinly, evenly, and above all, quickly spread. Being then allowed to dry in the dark, it rarely fails to produce a good picture. And what is very remarkable, it is *ipso facto* fixed as soon as dry, so at least as not to be injured by exposure to common day-light, immediately; and after a few days' keeping it becomes entirely so, and will bear strong lights uninjured. By long keeping, details at first barely seen come out, and the whole picture acquires a continually-increasing intensity, without however sacrificing distinctness; and by the same gradations its colour passes from purple to greenish-blue. Some experience, to be acquired only by practice, is necessary to determine the proper moment for withdrawing the photograph from the action of the light. If it be over-sunned, only the darker shades appear; if too little, the whole, though beautifully perfect in the first moments of its appearance, speedily runs into an indistinguishable blot.

233. The principal obstacle in the way of the employment of gold and silver as photographic ingredients for the production of negative models, to be used for re-transfers, so as to multiply positive copies, arises from the want of absolute opacity in these metals or their oxides when in a state of minute division. The same objection does not apply, or applies with much less force, to mercury, which (probably owing to its fluid state, which prevents its particles from acquiring that excessive tenuity which a laminated form would admit, by reason of their capillary forces contracting each separately deposited particle into a sphere) is one of the most opake substances (after carbon) known. I find that this high degree of blackness and opacity may be induced on a mercurial photograph prepared as in Art. 228, by a process which is in itself not a little curious and instructive, as affording a kind of parallel to the stimulating action of Mr. TALBOT's second application of nitrate of silver, in his beautiful kalotype process. The nature of the process in question will be best illustrated by describing the experiment which led to it.

234. It frequently happens that papers prepared with nitrate of mercury and the ammonio-citrates or tartrates, with or without addition of tartaric or citric acid, fail to exhibit the peculiar properties described in Arts. 228, 229 at all satisfactorily. Indeed, to bring on the peculiar velvety effect there described, a high degree of intensity of sunshine seems to be an essential requisite, as, in a feeble sun, I have never

obtained even an approach to it. A paper prepared (Oct. 28, 1842) according to the instructions of Art. 229 in every respect, except in the proportion of tartaric acid (which was somewhat less than that recommended), proved very little sensitive. A strip of this paper, half shaded, acquired after a few minutes' exposure to sunshine only a feeble brown colour over the sunned portion. Being then withdrawn, it was washed over with nitrate of mercury. *Immediately* the sunned portion began to darken very rapidly while the shaded part was unaffected, and ultimately assumed a deep brown hue. Exposed while yet wet to the sunshine, this passed rapidly to intense blackness, while the portion originally shaded, which had undergone the same subsequent application, and which was now equally exposed to the sun, sustained in the short time required for bringing on this effect, no appreciable change. Indeed it seemed rather to have become more insensible than before.

235. Not alone nitrate of mercury is capable of thus exciting or stimulating the dormant photographic impression on such paper. To my very great surprise, I found the same effect to be produced by *water* sparingly applied, so as only to moisten the paper. Across the sunned and shaded portions of a strip of the mercurialized paper, exposed till a pale brown was developed in the former portion, were drawn two streaks, one of weak nitrate of mercury and one of spring water. Both, after a very short interval, passed to an intense brown on the sunned half, the shaded remaining unchanged. Edging the streak produced by the nitrate was a black border, that produced by the water was uniform. The *whole* paper was now exposed for a short time to the sun, which rapidly converted to intense blackness both the streaks on the previously sunned half, while it produced no perceptible change in the other. I found this experiment to succeed on many different varieties of paper, and with very considerable latitude in the dosage of the ingredients. It was most successful in the case of a paper prepared with a cream, formed by mixing one measure ammonio-*tartrate* of iron (strength $\frac{1}{12}$*) and two saturated protonitrate of mercury, leaving out the free tartaric acid altogether, which, among many other doses of these two ingredients, proved also, generally, the most sensitive to light.

236. Led by these indications I prepared a paper by washing, first with a weak solution of ammonio-citrate of iron (strength $\frac{1}{20}$), and when dry, with saturated protonitrate of mercury. It was exposed *when barely dry enough, not to feel damp,* with an engraving in a frame to a hazy and declining sun. In about twenty minutes a very pale and feeble photograph was produced. Excited as above, by water, it gained but little in intensity (for it deserves remark that the *increase* of apparent intensity produced by either water or the nitrate, is in direct *proportion* to the force of the original impression, which, as observed, was in this case very faint). It was then held for about five minutes in the sun (near setting), and by degrees, and with the utmost regularity of gradation over every part of the picture, each line assumed an

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* By this I understand one part (by weight) salt + 11 water.

inky blackness, the lights and shades being exquisitely preserved in their due proportions, and the ground being hardly perceptibly discoloured. The result was a very beautiful and perfect negative photograph.

237. This singular power of water to excite the dormant impression, strongly recalls the analogous power of moisture to deepen the tints photographically impressed on auriferous papers, of which an instance is given in Art. 45, and of which a still more striking example is shown as follows. Let a paper be washed first with ammonio-citrate of iron, and when dry with neutralized chloride of gold, and thoroughly dried in the dark. It is then, apparently, almost insensible to light; a slip of it half exposed to sun being hardly impressed in any perceptible degree in many minutes; yet if breathed on, the impression comes out very strong and full, deepening by degrees to an extraordinary strength. Treated in the same manner, silver also exhibits a similar property*. Nor, indeed, is there any feature in photography more general or more remarkable than the influence exercised by the presence of a certain degree of moisture in favouring the action of light, whether direct or indirect.

238. There is this difference, however, in the excitement produced by simple water and by the mercurial solution, viz. that the latter is permanent, the former liable to fade; at least I have found this to be the case with the brown tinge produced by it in shade, though when blackened by a second exposure to sun no difference is perceived. On the other hand, when the nitrate is used, the brown hue frequently passes to absolute blackness without any subsequent exposure to sunshine; and in that case the photographs produced have an intensity and opacity scarcely, if at all, inferior to that of printing ink.

239. This high degree of opacity and depth, together with the comparative insensibility of the ground, is evidently capable of being most usefully applied to the production of retransfers. In fact, the photographs so produced being negative are so far fitted for the purpose, and if used as models while in this, their transition state, and as it were self-fixed, so far from being injured by the transmission of light, they are actually acquiring additional sharpness and depth by every beam which passes. By *seizing therefore the right point of dryness*, and by using a very sensitive paper to receive the impression, there is no reason to doubt of success in procuring very perfect positive transfers. Some trials I have made have satisfied me as to the practi-

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* Note added Dec. 21.—The excitement is produced on such paper by the ordinary moisture of the atmosphere, and goes on slowly working its effect in the dark, apparently without *other* limit than is afforded by the supply of ingredients present. In the case of silver, it ultimately produced a perfect *silvering* of all the sunned portions. Very singular and beautiful photographs having much resemblance to Daguerreotype pictures, are thus produced; the negative character changing by keeping, and by quite insensible gradations, to positive; and the shades exhibiting a most singular *chatoyant* change of colour from ruddy-brown to black when held more or less obliquely. No doubt also gold pictures with the metallic lustre might be obtained by the same process, though I have not tried the experiment.—J. F. W. H.

cability of this, however contrary it may at first sight appear to the usual conditions of photography.

240. In the positive cyanotype process, as improved by the addition of corrosive sublimate above recommended, we are furnished with another instance of a transformation effected by heat, analogous to those described in Art. 223. A picture prepared by this process, if heated, is transformed from positive to negative and from blue to brown. On keeping the blue colour is restored, *as well as the positive character.* In Art. 224 I have referred this curious action to certain rays, which, whether they be regarded as rays of heat, or light, or of some influence, *sui generis,* accompany in the spectrum the red and orange rays, and are also copiously emitted by heated bodies short of redness. These rays are distinguished from those of light by being invisible; they are also distinguished from the purely calorific rays beyond the spectrum by their possessing the properties recorded in Arts. 160, 223, either exclusively of the calorific rays, or in a very much higher degree. They may perhaps not improperly be regarded as bearing the same relation to the calorific spectrum which the photographic rays do to the luminous one, and if the restriction to these rays of the term *thermic* as distinct from *calorific* be not (as I think in fact it is not) a sufficient distinction, I would propose the term *parathermic rays* to designate them. These are the rays (if I may indulge in speculation which I propose to bring to the test of experiment hereafter) which I conceive to be active in producing those singular molecular affections which determine the precipitation of vapours in the experiments of Messrs. DRAPER, MOSER, and HUNT, and which will probably lead to important discoveries as to the intimate nature of those forces resident on the surfaces of bodies to which M. DUTROCHET has given the name of epipolic forces. These also, I cannot help considering it as highly probable, are the rays which radiated from molecule to molecule in the interior of bodies, determine the discharge of vegetable colours at the boiling temperature (see Art. 162), and the innumerable isomeric and other atomic transformations of organic bodies which take place at temperatures below redness. The term latent light, I confess, carries with it to my mind no distinct conception; still less capable of being introduced into scientific language appears such a term as *invisible* light. Whether the rays to which such terms have been applied shall or shall not turn out, on inquiry, to be identical with my "parathermic" rays, can only be decided by experiments to be instituted for that purpose; but at all events I feel strongly disposed to insist on the distinction between *these* rays and those of *pure heat,* and in referring them to a peculiar region of the spectrum (though without denying their more sparing distribution over every other part of it), I consider them at all events as sufficiently identified by their characters, there eminently developed, to become legitimate objects of scientific discussion.

241. The action of the calorific rays, *as such,* demonstrated by the rapidity of evaporation of water or alcohol which takes place under their influence, is traced (in addition to the facts brought forward in the notes on my first paper on this subject)

in the experiments described in Arts. 205, 208, in the latter of which a chemical action, distinct from the calorific, seems also traceable. I may here also mention that the rays which operate the change of colour in muriate of cobalt from rose colour to green appear to be the calorific rays generally, and the effect to be one of simple evaporation; since under the action of the spectrum I find the green colour not restricted to the "parathermic" region, but to extend far beyond the red, and to be, in fact, commensurate with the calorific spectrum, so far as it could be traced in an experiment made under unfavourable circumstances.

I have the honour to remain, my dear Sir,
Yours very truly,
J. F. W. Herschel.

Collingwood, Nov. 15, 1842.

II. *Researches on the Decomposition and Disintegration of Phosphatic Vesical Calculi, and on the Introduction of Chemical Decomponents into the Living Bladder. By* S. Elliott Hoskins, *M.D. Communicated by* P. M. Roget, *M.D., Sec. R.S.*

Received December 8, 1842,—Read February 23, 1843.

In the following account of my humble investigations, I shall confine myself, as much as possible, to the physical phænomena which have fallen under my observation; reserving those of a physiological or pathological character for a sphere more exclusively professional.

Although Fourcroy strongly expressed it as his opinion, that calculi would, sooner or later, be dissolved by the introduction of chemical agents into the living bladder; and, although some eminent writers of the present day are of the same opinion; there are others, no less eminent, who entertain doubts as to the adaptation of any direct chemical means to so desirable an end.

I must here state, that my reason for clinging to the creed of the former rather than to that of the latter, was founded on the increasing list of new agents, which chemistry is daily placing at the disposal of the experimenter. Amongst these I hoped to discover some agent which should be more energetic in its action on calculi, and less obnoxious to the living tissues, than any hitherto proposed.

For several months my efforts were confined to attempts at dissolving uric acid and the urates, knowing that they constitute a predominating variety among calculous concretions: and, although I met with sufficient success to encourage perseverance, reasons not necessary to mention, induced me to abandon these experiments, and to prosecute others on phosphatic calculi. The results of the latter it is now my purpose to detail.

A series of experiments was undertaken with the whole range of acids, vegetable as well as mineral, combined in various ways and in various proportions. There could be no doubt as to the solvent power even of the weakest; but their irritating effect on the tongue, and on the conjunctival membrane, was equally obvious. Not one among them was found calculated to fulfil the two indications I required; a circumstance which tends to corroborate, in a great degree, Dr. Prout's statement,—"that uncombined agents of the alkaline or acid kind are ill-calculated to act as solvents for calculi; and that solvents are to be sought for among a class of harmless and unirritating compounds, the elements of which are so associated as to act at the same time with respect to calculous ingredients, both as alkalies and acids*."

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* Prout on the Stomach and Urinary Diseases, p. 458.

"At present," continues Dr. Prout, "no such class of compounds of a decided character are known, or appear likely to be discovered; yet, as no chemical fact can be stated *à priori*, we know not what remains in store among the arcana of nature."

The conviction I had acquired of the truth of these observations induced me to abandon all attempts at positive or direct solution, but rather to try the effect of indirect means, namely those of *decomposition* and disintegration; as preliminaries to solution by some bland fluid, or to mechanical removal, by the injection of a continuous stream of liquid through a double current catheter.

It appeared, hitherto, to have been the object, to act on calculi by *single* elective affinity only; that is, to dissolve the base before it was disengaged from its associated acid. This mode having failed to produce agents sufficiently active on the one hand, and mild on the other; it seemed more in accordance with chemical principles, and more likely to effect the desired end, if *complex* affinity could be brought into play.

It frequently happens, that reactions occur under the influence of double decomposition, which are not produced by simple affinity: thus, ammonia alone will not decompose nitrate of lime, though carbonate of ammonia answers the purpose readily. The triteness of this example will, I trust, be excused in favour of the aptitude with which it illustrates my meaning.

For the above purpose an agent is required, the base of which shall be so attractive of the acid of the calculus, as to withdraw it from its allegiance; whilst the acid of the agent unites with the basic ingredients of the calculus, to form with them salts of easy solution.

This view of the subject seems to reveal a class of agents so mild as to come directly under Dr. Prout's category. During their employment, the combined acids are set free *only* in combining proportions, to be neutralized in their nascent state by the proper base, and *removed out of the sphere of action before they have time, as it were, to act upon the animal tissues.* Whereas, free acids of sufficient strength to act on the concretion, and in sufficient quantity, cannot be prevented from irritating, in a greater or less degree, the animal membranes with which they happen to be in contact.

The facility with which salts of lead decompose the phosphates, a facility which has led to their employment as tests of the presence of phosphoric acid, pointed them out as agents well-fitted for the present purpose.

Fragments of phosphatic calculi were accordingly immersed in solutions of neutral acetate of lead, of various degrees of concentration, and at different temperatures, but without result; even when the assay, reduced to powder, was placed in these fluids and viewed with the microscope, no chemical action, however slight, was discernible. I was disappointed, but nevertheless induced to try some other combination of the metal.

Dr. Prout mentions, in his valuable work before cited, that fluids containing malic acid possess peculiar powers in arresting the deposition of the phosphates. The same gentleman informed me that the solvent powers of the *Alchemilla arvensis* reside in the malic acid which this plant contains, My own experience has unequivocally proved to me the efficacy of cider, as an ordinary drink, in cases of phosphatic urinary deposit accompanying rickets, and diseases of the lumbar vertebræ.

From these circumstances I was inclined to believe, that although the acetate had failed, a malate or super-malate of lead would be likely to act as a decomponent of phosphatic concretions. Another reason for selecting malic acid was the solubility of the salts it forms with the bases of these calculi, viz. magnesia, lime, &c. Having no readier means of procuring the malate, I sought to prepare it from cider vinegar, or what is called *cidre-aigre* in contra-distinction to *vin-aigre*, a liquid commonly used as a substitute for wine or malt-vinegar, in the farm-houses and cottages of the Channel Islands.

To this *cidre-aigre* a watery solution of neutral acetate of lead was added, till precipitation no longer took place. The liquid, on being filtered, was clear, devoid of acidity or acrimony; and, as Dr. CHRISTISON states, with respect to acescent wines to which lead has been added, it possessed "a very pleasant sweetness, quite unmingled with metallic astringency*."

The whole of the passage, relating to French wines, from which the above sentence is quoted, seems particularly applicable to the liquid under consideration. In default, however, of any authentic analysis of cider-vinegar, my observations induced me to believe, that the acids it contained were the acetic, malic, and tartaric; but as I was unwilling to interrupt the course of experiments, in order to analyse it, I am unable to determine this point with the necessary accuracy.

Nevertheless, whatever may be its composition, the immersion of fragments of phosphatic calculi in the liquid formed as before stated, was followed by very striking results: rapid chemical action ensued, visible to the naked eye; when viewed by means of a low microscopic power, vehement decomposing action was manifest, the calculous particles becoming surrounded by *areolæ* or *nebulæ* of white sediment, which continued increasing until each fragment was reduced to a pulpy state resembling mortar, perfectly soluble in very dilute nitric acid.

On suspending a fragment of fusible calculus, by means of horse-hair, in a test-glass containing the fluid, it became at once involved in a white cloud, from which a continuous stream of precipitate gravitated to the bottom of the glass. After the lapse of half an hour the calculus was found to have lost weight. This was an important fact, without which it might have been supposed that decomposition of the solution alone had given rise to the precipitate.

Being inclined to doubt the evidence of my senses, rather than arrive at a false conclusion, I repeated the experiment. Another particle of triple phosphate was placed in a fresh quantity of the liquid; at the moment of immersion chemical action commenced, and pursued the same course, until the fragment became a semi-solid mass, readily disintegrated. After a time nothing remained but the shreds of mucus, or other animal matter, which had cemented the earthy ingredients together.

The result of analogous experiments, performed subsequently, warrants me in stating that the precipitate in the present instance was chiefly phosphate of lead*; it may likewise be fairly inferred, that the other ingredients composing the calculus had formed soluble salts with the malic and acetic acids of the decomponent. For it was manifest that the acids contained in *cidre-aigre* had formed soluble salts with oxide of lead, and that these salts, even when dissolved in such a quantity of fluid as to possess scarcely any taste and no pungency, were capable of decomposing phosphatic calculi. The liquid in this state, however, was objectionable, in a practical as well as a scientific point of view, on account of its colour, odour, and indeterminate strength. It therefore became desirable to attempt the formation of some definite salt, of analogous composition, which, by solution in water, should form a decomposing agent, of a strength which might at all times be depended on; capable also of being varied according to circumstances.

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* CHRISTISON on Poisons, p. 407.

In theory, the nearest approach to an agent of this kind seemed to be a super malate of lead; for, although the neutral malate was known to be insoluble in water, it was deemed possible that, by some modification, its solubility might be increased. This I found to be the case.

Crystals of malate of lead, in fine powder, were diffused in water, and thoroughly decomposed by sulphuretted hydrogen, so as to leave malic acid in solution; this was filtered and boiled to expel the gas. While still hot, fresh crystals of malate of lead were added to the fluid, which was then allowed to cool, and again filtered. On suspending specimens of phosphatic calculi in this liquid (which, though sensibly acid when tested, was perfectly insipid), chemical action took place, but by no means rapidly. This was, nevertheless, one step towards the acquirement of a definite compound.

Recurring to my former conjectures as to the nature of the salts held in solution by the filtered *aigre*, pure crystals of malate of lead were gradually added to warm dilute acetic acid†. This mixture was heated gently for some time, and afforded a better decomponent than the former, but still not so active as the original cider-vinegar compound.

After a long series of experiments to the same effect, which it is unnecessary to detail, I arrived at the following conclusions:—1st, that malic acid, unless concentrated, exerts but little solvent action on phosphatic calculi; 2nd, that a weak solution of super-malate of lead *does* act as a decomponent; 3rd, that a solution of aceto-malate, if I may be allowed so to call the liquid last described, is tolerably active; but finally, that none of the preparations of malic acid, already alluded to, are so active as the cider-vinegar solution.

The close resemblance said to exist between genuine malic acid, procured from the *Sorbus aucuparia*, and the factitious, prepared by the action of dilute nitric acid on sugar, induced me to turn my attention to what, by some chemists, is called saccharic, by others oxal-hydric acid. By slightly varying BERZELIUS's process‡, so as to avoid the discoloration produced, as he says, by humic acid, a very pure saccharate of lead was prepared. From this, saccharic acid and super-saccharate of lead were obtained by the aid of sulphuretted hydrogen, as described when speaking of the malates of lead. Saccharic acid, however, unless concentrated, exerted no greater influence on phosphatic concretions than malic acid; the neutral saccharate of lead was likewise inert, whereas the supersalt proved so active, and yet so mild, that it seemed better calculated than any agent hitherto tried, to fulfil the prescribed conditions. But as the sulphuretted hydrogen process was tedious and unpleasant, **Thenard**'s statement as to the solubility of the malate in acetic acid was applied to the saccharate of lead: a preparation of this kind seemed the more likely to answer from its similarity to the *cidre-aigre* solution.

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* See p. 280.

† Five parts of pure acid to 480 of distilled water.

‡ This modification consists in heating the mixture of dilute acid and sugar, until the evolution of red fumes

An *aceto-saccharate* was, in the first instance, formed according to **Berzelius**'s directions*; but as this process was likewise somewhat elaborate, I endeavoured to abbreviate it as follows:—Five parts of saccharate of lead, and the same number of minims of strong acetic acid, were added to a fluid ounce of distilled water, which was gently heated for a short time; a small quantity of the lead salt was thereby dissolved, not more than half a grain. This solution, although perfectly tasteless, acted speedily and with energy on any phosphatic fragment of calculus suspended in it. The solution on the most careful evaporation yielded no crystals, but was converted by heat into a viscous syrup, which ultimately became a species of *caramel*. The liquid, therefore, although available for experimental, was not sufficiently definite for practical purposes. But as **Liebig** mentions no less than three definite compounds of oxide of lead with saccharic acid, I did not despair of succeeding in the formation of a salt, such, in all respects, as I required. "L'acide saccharique," says **Liebig**, "est très rémarquable par le grand nombre de combinaisons qu'il forme avec les bases."

It now became my object to form an *acid* saccharate of lead, which was accomplished thus:—a portion of pulverized saccharate of lead was dissolved in a sufficient quantity of cold dilute nitric acid†. The solution, after being filtered, and gradually evaporated, yielded a quantity of perfectly transparent, amber-coloured crystals, in the form of regular hexagonal plates or prisms. I have reason to believe that the colour is essential to the salt, for when I endeavoured to purify it by re-solution in dilute nitric acid, although it still formed hexagonal crystals, the salt had lost its activity as a decomponent.

One grain of this salt, which I shall call nitro-saccharate of lead, moistened with

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commences, and then instantly removing the spirit-lamp. The fumes continue to be disengaged for some time, and when they have entirely ceased, decomposition by lime, and precipitation by acetate of lead may ensue.

* "Quand on chauffe," says he, "un mélange d'acide acétique et de saccharate calcique dissous, et qu'on ajoute à ce mélange de l'acétate d'oxyde de plomb jusqu' à ce que le précipité commence à ne plus se rédissoudre, le sel écailleux cristallise en plus grande quantité par le refroidissement." These crystalline scales, moistened with acetic acid, and dissolved in water, form a good decomponent.

† One acid to nineteen water.

five drops of pure saccharic acid, and dissolved in a fluid ounce of distilled water, formed a bland liquid without any astringency, although it possessed slight acid reaction. It acted with rapidity on various specimens of phosphatic calculi, forming around each, at the moment of immersion, the dense nebula formerly described, from which a white precipitate subsided. Chemically speaking, this was the most active agent yet experimented with, whilst its sensible character was so mild as to be tolerated with perfect impunity by the urethral and conjunctival membranes.

The following experiments, selected from a great number of others, to the same effect, will suffice to show the results of the action of this nitro-saccharate solution on human phosphatic calculi.

Experiment I.—Seven fragments of various sizes and figures, taken indiscriminately from a collection of phosphatic specimens, were placed in distilled water until air-bubbles ceased to be disengaged from them: they were found to weigh collectively, after being allowed to drain for a minute or two on bibulous paper, one hundred grains.

These fragments, each suspended by a horse-hair, were placed in ten fluid ounces of the above-mentioned nitro-saccharate solution for twenty-five minutes, during which time the temperature of the fluid was maintained at 98° FAHR. They were then removed and plunged into ten ounces of fresh solution, of the same strength and temperature, for a quarter of an hour. In both cases, copious precipitation took place from each fragment, and accumulated at the bottom of the glasses. The calculi were then removed, drained for a few minutes on filtering paper, and, on being re-weighed, were found to have lost twelve grains*.

The two portions of solution, together amounting to twenty ounces, were then passed through a filter; and the precipitate, after being washed and carefully dried, was found to weigh *eleven* grains. A small quantity of it, heated alone on charcoal by means of the blowpipe, gave indications of the presence of phosphate of lead. In order, however, to determine the nature of the acid contained in the lead precipitate, another portion of it was dissolved in dilute nitric acid; to this solution was added a drop or two of nitrate of silver, and on being cautiously neutralized by weak liquid ammonia, a yellow precipitate, characteristic of the presence of phosphate of silver, made its appearance†.

A third portion of the dried precipitate was mixed with borax, and fused by the blowpipe on charcoal; the bead thus formed was transfixed by a fine needle, and strongly heated in the interior flame; on being broken after cooling, it was found to consist of magnetic particles of phosphuret of iron, affording another proof of the presence of phosphoric acid in the precipitate.

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* The greater the extent of surface, the greater, generally speaking, will be the amount of decomposition, so that agents of this kind will, I trust, come with great effect to the aid of *lithotrity*.

† I may perhaps be permitted to remark, that in order to render this test determinate, the following precaution is necessary. If the assay be dissolved in *dilute* nitric acid, *weak* liquid ammonia must be used for neutralization, otherwise no yellow precipitate will be formed. On the other hand, if *strong* nitric acid is used for solution, it must be neutralized by strong liquid ammonia. In both cases the ammonia must be added cautiously, for an excess, however small, destroys the yellow colour of the precipitate.

With respect to the filtered solution, half of it, amounting to ten ounces, on being cautiously evaporated to dryness, yielded rather more than nine grains of solid residue, which, however, was not analysed. The remaining ten ounces were treated with sulphuretted hydrogen, so as to decompose the *whole* of the salt of lead: it was then filtered, boiled, and tested with oxalate of ammonia, which produced after a time a trifling precipitation of lime: the superaddition of liquid ammonia gave no evidence of the presence of magnesia.

At the commencement of the experiment the solid materials amounted to 120 grains, viz.—

Seven calculous fragments . . . . = 100 grs.
Nitro-saccharate of lead in solution . . . . = 20
120

After the operation the following seems to have been the arrangement of the ingredients:—

Calculous fragments after immersion for forty minutes . . . = 88 grs.
Precipitate separated by filtration and dried . . . . = 11
Residue of filtered fluid after evaporation . . . . = 19
Unaccounted for . . . . = 2
120

Supposing the precipitate from the calculi to have consisted entirely of phosphate of lead, the equivalent of acid would, on a rough calculation, have been 2·4; so that, had the assay been inorganic, or definite in composition, the exact amount of decomposed salt might have been estimated. Under existing circumstances rude approximations are sufficient; but I hope to be enabled to illustrate this part of the subject at some future period, by more careful and extended analyses.

The *second experiment* was conducted by suspending a fragment of fusible calculus, weighing thirty grains, in five ounces of the nitro-saccharate solution for half an hour. At the expiration of this period the fragment had lost eight grains, and the precipitate arising from its decomposition, when carefully dried, weighed rather more. The filtered fluid, treated as in the former experiment, contained a small quantity of lime.

In the course of the present experiment some very curious and interesting phænomena were observed. A copious, dense, white sediment, descended as usual in a stream from the calculus; but, besides this, an ascending current was remarked: it consisted of air bubbles, bearing with them a white stream, similar to, though smaller than that which was seen descending; on arriving at the surface the bubbles escaped, and the white particles they had rendered buoyant, subsided steadily, like sparks from an exploded rocket. This circulation, similar to the ascending and descending currents produced in liquids by heat, continued until decomposition from saturation of the solution, or other causes had ceased.

The same fragment was afterwards immersed in other solutions of a similar kind, with a view of ascertaining its rate of decomposition:—but after decomposition had been going on steadily for some time, precipitation *suddenly* ceased. Under the idea that precipitation had ceased in consequence of the solution having become saturated, fresh quantities were tried, but without any renewal of chemical action; although other phosphatic fragments plunged into the same fluid were readily acted on. The cause of cessation, therefore, could only be attributed to some change in the character of the assay; on examination, instead of being white, friable, and homogeneous in texture, it had become fawn-coloured, dense, and striated; and yielded unequivocally, uric acid reaction. This accounted for the abrupt cessation of chemical action, and bore testimony to the effects of the saturnine solution on the phosphatic ingredients; for it was evident that the latter had constituted the outer coating of an uric acid nucleus in the fragment under examination.

The result of experiments with other salts of lead, as well as with those of mercury, baryta, and others, confirm the facts already stated; viz. that almost all supersalts of lead, especially with vegetable acids, act as ready decomponents of the calculi under consideration. Even the acetate, which in its neutral state is inert, becomes active by the superaddition of a minute quantity of its own proper acid: and, in like manner, the addition of a few drops of lactic*, malic, racemic, or formic acids to solutions of their neutral salts, produces a class of active decomposing agents, so effectual, that either of them may be considered to afford secure means for discriminating the phosphatic from other varieties of calculi.

An interesting and perchance important circumstance connected with this part of the subject, relates to the *strength* of the solution, which appears to be in *inverse ratio* to its decomposing power. Thus, a saturated solution of acetate of lead, acidulated pretty strongly with acetic acid, is inactive; whereas, one grain of the salt, with five drops of the acid, dissolved in one fluid ounce of tepid water, produces rapid and steady decomposition.

This fact has been carefully verified by repeated experiments; for instance, the moment a portion of calculus, which had been steadily decomposing in a weak solution, is plunged into a stronger, action abruptly ceases; it is as suddenly re-established when the assay is returned to the weaker solution. This alternation from weak to strong, and the reverse, was often repeated with solutions variously modified, but invariably with the same general result.

On first remarking the above circumstance, I was not aware that **Berzelius** had previously recorded a somewhat similar fact in relation to the action of weak solutions of borate of soda on uric acid; and that, on the authority of **Wetzlar**, he had stated that uric acid is soluble in *weak* solutions of *carbonate* of potash*.

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* When a fragment of phosphatic calculus is placed in a solution of super-lactate of lead, under the microscope a dense areola at first surrounds it; from this, after a time, radii proceed, until the assay assumes a stellar appearance, of dazzling whiteness.

The preceding experiments being apparently conclusive as to the decomposing effect of certain salts of lead on phosphatic calculi, out of the body; the next point to be determined was the effect likely to be produced by the introduction of their solutions into the living bladder. They had been found, on repeated trial, inoffensive to the eye and to the urethra; they are constantly applied to abraded and inflamed surfaces, as well as used internally, with the greatest advantage: and, although some of these salts, by long-continued absorption, are apt to produce a train of specific morbid symptoms, it has been stated by physicians of eminence, that lead acts deleteriously only when imbibed in the shape of a carbonate; that when the acetate appears to produce *colica pictonum*, it does so from being converted, after its reception into the body, into a carbonate; and furthermore, that this conversion may be avoided by super-acidulation, the salt may then be administered with perfect safety in large and efficient quantities. My observations tend to prove, that this super-acidulation is *essential* to the due action of the decomposing fluids I propose. Whatever salt of lead may be employed must be moistened with a small quantity of its own proper acid, or a few drops of pure acetic acid, PREVIOUS to the addition of water. In a chemical as well as therapeutical point of view this is essential:—1st, it secures the perfect solution of the salt and its consequent activity as a decomponent; 2nd, the super-addition of acid secures against the formation of any of the deleterious carbonate.

In order, however, that I might be perfectly satisfied as to the comparatively innocuous qualities of the before-named salts, I undertook a series of experiments with them on sheep; introducing the fluids into the bladder daily, for several weeks consecutively, and having the animals killed at different periods during the investigation. In none of the sheep experimented on, were untoward symptoms excited, either general or local.

It may be objected, that the membrane lining the viscera of graminivorous animals is less susceptible than that which performs the same office in man; but as, on trial, liquids which irritate and inflame the human organs, act in the same way, and with the same rapidity on those of the sheep, I see no reason to believe that the one is less susceptible of such impressions than the other. Experiments of a personal nature, not necessary to particularize, were also resorted to, and contributed to the conviction, that no evil could accrue from the continued introduction of saturnine solutions into the bladder†. The following cases not only prove this fact, but furthermore that the solutions are freely tolerated by the organ, even when rendered morbidly irritable by the presence of the stone.

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* "Quand la liqueur ne contient qu'un demi pour cent de carbonate alcalin, l'acide urique s'y dissout assez rapidement." **Berzelius**, Traité de Chimie.

† I refrain, for obvious reasons, from entering into particulars as to the general effect of solutions of the salts of lead in various morbid states of the bladder; although I may be allowed perhaps to direct attention to the property these salts possess of coagulating mucus,—a property they do not fail to exercise on the secretion from the living organ, independently of their decomponent effects on the phosphate of lime which that secre-

The first case to be mentioned is that of a gentleman, seventy years of age, who had long been suffering from vesical affection, accompanied by alkaline urine, phosphatic sediment, and the copious formation of ropy mucus. The catheter, when introduced, was felt to grate over calcareous concretions imbedded in the prostate gland.

In this case, a very dilute solution of nitric acid, one drop to the ounce of water, could only be retained a minute or two, its use being followed by considerable pain, which lasted for several hours; whereas the nitro-saccharate of lead solution, although retained for *fifty* minutes, produced no inconvenience, either at the time or subsequently. It was repeated daily, or every second day, for upwards of a month, and has been again resumed at the patient's request*.

The second case was one in which two calculi existed; the one was crushed successfully. The bladder was extremely irritable; nevertheless, the solution, injected at frequent intervals, for a fortnight or three weeks, produced no greater uneasiness at the time, or irritability afterwards, than an equal quantity of warm water. The fragments voided by this patient were found to consist of a mulberry nucleus with a coating of phosphatic material, readily acted upon by the solution.

The third case was also one of phosphatic calculus in an irritable bladder. The solution of nitro-saccharate was used daily for a week, and retained for half an hour at a time, not only without annoyance, but often with positive comfort. The gentleman, however, not having patience to await its action on the calculus, nothing further was ascertained.

It will be sufficiently evident, from these mere outlines, that the cases themselves were utterly unfavourable for testing the LITHONTRIPTIC powers of the solution: they are, nevertheless, well-fitted to afford evidence of its being neither irritating nor injurious, when introduced with proper restrictions into the bladder.

The establishment of the latter fact, although an important feature in the present communication, is not more so than the results which tend to denote the advantage of using DECOMPONENTS, rather than solvents. The latter view of the subject reveals a class of mild, but effectual, agents hitherto untried, and points out a principle, the application of which, I trust and anticipate, will lead to the discovery of similar agents for the *decomposition* of the other varieties of calculi which afflict the human race.

Guernsey, December 1, 1842.

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tion often contains. Other matters connected with the mechanical means for introducing the fluid, the action of various decomponents contained in the urine, &c., must be reserved for consideration elsewhere.

* This gentleman is, I understand, much benefited. The instrument is no longer felt to grate over calcareous matter; and he voids the vesical contents more freely.

III. *Experimental Researches in Electricity.—Eighteenth Series.*

By Michael Faraday, *Esq., D.C.L. F.R.S., Fullerian Prof. Chem. Royal Institution, Corr. Memb. Royal and Imp. Acadd. of Sciences, Paris, Petersburgh, Florence, Copenhagen, Berlin, Göttingen, Modena, Stockholm, &c. &c.*

Received January 26,—Read February 2, 1843.

§ 25. *On the electricity evolved by the friction of water and steam against other bodies.*

2075. Two years ago an experiment was described by Mr. Armstrong and others[*], in which the issue of a stream of high pressure steam into the air produced abundance of electricity. The source of the electricity was not ascertained, but was supposed to be the evaporation or change of state of the water, and to have a direct relation to atmospheric electricity. I have at various times since May of last year been working upon the subject, and though I perceive Mr. Armstrong has, in recent communications, anticipated by publication some of the facts which I also have obtained, the Royal Society may still perhaps think a compressed account of my results and conclusions, which include many other important points, worthy its attention.

2076. The apparatus I have used was not competent to furnish me with much steam or a high pressure, but I found it sufficient for my purpose, which was the investigation of the effect and its cause, and not necessarily an increase of the electric development. Mr. Armstrong, as is shown by a recent paper, has well effected the latter[†]. The boiler I used, belonging to the London Institution, would hold about ten gallons of water, and allow the evaporation of five gallons. A pipe 4½ feet long was attached to it, at the end of which was a large stop-cock and a metal globe, of the capacity of thirty-two cubic inches, which I will call the *steam-globe*, and to this globe, by its mouth-piece, could be attached various forms of apparatus, serving as vents for the issuing steam[‡]. Thus a cock could be connected with the steam-globe, and this cock be used as the experimental steam-passage; or a wooden tube could be screwed in; or a small metal or glass tube put through a good cork, and the cork screwed in; and in these cases the steam way of the globe and tube leading to the boiler was so large, that they might be considered as part of the boiler, and these terminal passages as the obstacles which, restraining the issue of steam, produced any important degree of friction.

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[*] Philosophical Magazine, 1840, vol. xvii. pp. 370, 452, &c.

[†] Ibid. 1843, vol. xxii. p. 1.

[‡] This globe and the pieces of apparatus are represented upon a scale of one-fourth in the Plate belonging to this paper.

2077. Another issue piece consisted of a metal tube terminated by a metal funnel, and of a cone advancing by a screw more or less into the funnel, so that the steam as it rushed forth beat against the cone (Plate I. fig. 2.); and this cone could either be electrically connected with the funnel and boiler, or be insulated.

2078. Another terminal piece consisted of a tube, with a stop-cock and feeder attached to the top part of it, by which any fluid could be admitted into the passage, and carried on with the steam (fig. 3.).

2079. In another terminal piece, a small cylindrical chamber was constructed (fig. 4.) into which different fluids could be introduced, so that, when the cocks were opened, the steam passing on from the steam-globe (2076.) should then enter this chamber and take up anything that was there, and so proceed with it into the final passage, or out against the cone (2077.), according as the apparatus had been combined together. This little chamber I will always call C.

2080. The pressure at which I worked with the steam was from eight to thirteen inches of mercury, never higher than thirteen inches, or about two-fifths of an atmosphere.

2081. The boiler was insulated on three small blocks of lac, the chimney being connected by a piece of funnel-pipe removable at pleasure. Coke and charcoal were burnt, and the insulation was so good, that when the boiler was attached to a gold-leaf electrometer and charged purposely, the divergence of the leaves did not alter either by the presence of a large fire, or the abundant escape of the results of the combustion.

2082. When the issuing steam produces electricity, there are two ways of examining the effect: either the insulated boiler may be observed, or the steam may be examined, but these states are always contrary one to the other. I attached to the boiler both a gold-leaf and a discharging electrometer, the first showed any charge short of a spark, and the second by the number of sparks in a given time carried on the measurement of the electricity evolved. The state of the steam may be observed either by sending it through an insulated wide tube in which are some diaphragms of wire gauze, which serves as a discharger to the steam, or by sending a puff of it near an electrometer when it acts by induction; or by putting wires and plates of conducting matter in its course, and so discharging it. To examine the state of the boiler or substance against which the steam is excited, is far more convenient, as Mr. Armstrong has observed, than to go for the electricity to the steam itself; and in this paper I shall give the state of the former, unless it be otherwise expressed.

2083. Proceeding to the cause of the excitation, I may state first that I have satisfied myself it is not due to evaporation or condensation, nor is it affected by either the one or the other. When the steam was at its full pressure, if the valve were suddenly raised and taken out, no electricity was produced in the boiler, though the evaporation was for the time very great. Again, if the boiler were charged by excited resin before the valve was opened, the opening of the valve and consequent evaporation did not affect this charge. Again, having obtained the power of constructing steam passages which should give either the positive or the negative, or the neutral state (2102. 2110. 2117.), I could attach these to the steam way, so as to make the boiler either positive, or negative, or neutral at pleasure with the same steam, and whilst the evaporation for the whole time continued the same. So that the excitation of electricity is clearly independent of the evaporation or of the change of state.

2084. The issue of *steam alone* is not sufficient to evolve electricity*. To illustrate this point I may say that the cone apparatus (2077.) is an excellent exciter: so also is a box-wood tube (2102. fig. 5.) soaked in water, and screwed into the steam-globe. If with either of these arrangements, the steam-globe (fig. 1.) be empty of water, so as to catch and retain that which is condensed from the steam, then after the first moment (2089.), and when the apparatus is hot, the issuing steam excites no electricity; but when the steam-globe is filled up so far that the rest of the condensed water is swept forward with the steam, abundance of electricity appears. If then the globe be emptied of its water, the electricity ceases; but upon filling it up to the proper height, it immediately reappears in full force. So when the feeder apparatus (2078.) was used, whilst there was no water in the passage-tube, there was no electricity; but on letting in water from the feeder, electricity was immediately evolved.

2085. The electricity is due entirely to the friction of the particles of water which the steam carries forward against the surrounding solid matter of the passage, or that which, as with the cone (2077.), is purposely opposed to it, and is in its nature like any other ordinary case of excitement by friction. As will be shown hereafter (2130. 2132.), a very small quantity of water properly rubbed against the obstructing or interposed body, will produce a very sensible proportion of electricity.

2086. Of the many circumstances affecting this evolution of electricity, there are one or two which I ought to refer to here. Increase of pressure (as is well illustrated by Mr. ARMSTRONG's experiments) greatly increases the effect, simply by rubbing the two exciting substances more powerfully together. Increase of pressure will sometimes change the positive power of a passage to negative; not that it has power of itself to change the quality of the passage, but as will be seen presently (2108.), by carrying off that which gave the positive power; no increase of pressure, as far as I can find, can change the negative power of a given passage to positive. In other phenomena hereafter to be described (2090. 2105.), increase of pressure will no doubt have its influence; and an effect which has been decreased, or even annihilated (as by the addition of substances to the water in the steam-globe, or to the issuing current of water and steam), may, no doubt, by increase of pressure be again developed and exalted.

2087. The shape and form of the exciting passage has great influence, by favouring more or less the contact and subsequent separation of the particles of water and the solid substance against which they rub.

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* Mr. ARMSTRONG has also ascertained that water is essential to a high development. Phil. Mag. 1843, vol. xxii. p. 2.

2088. When the mixed steam and water pass through a tube or stop-cock (2076.), they may issue, producing either a hissing smooth sound, or a rattling rough sound*; and with the cone apparatus (2077. fig. 2.), or certain lengths of tube, these conditions alternate suddenly. With the smooth sound little or no electricity is produced; with the rattling sound plenty. The rattling sound accompanies that irregular rough vibration, which casts the water more violently and effectually against the substance of the passage, and which again causes the better excitation. I converted the end of the passage into a steam-whistle, but this did no good.

2089. If there be no water in the steam-globe (2076.), upon opening the steam-cock the *first effect* is very striking; a good excitement of electricity takes place, but it very soon ceases. This is due to water condensed in the cold passages, producing excitement by rubbing against them. Thus, if the passage be a stop-cock, whilst cold it excites electricity with what is supposed to be steam only; but as soon as it is hot, the electricity ceases to be evolved. If, then, whilst the steam is issuing, the cock be cooled by an insulated jet of water, it resumes its power. If, on the other hand, it be made hot by a spirit-lamp before the steam be let on, then there is *no* first effect. On this principle, I have made an exciting passage by surrounding one part of an exit tube with a little cistern, and putting spirits of wine or water into it.

2090. We find then that particles of water rubbed against other bodies by a current of steam evolve electricity. For this purpose, however, it is not merely water but *pure* water which must be used. On employing the feeding apparatus (2078.), which supplied the rubbing water to the interior of the steam passage, I found, as before said, that with steam only I obtained no electricity (2084.). On letting in distilled water, abundance of electricity was evolved; on putting a small crystal of sulphate of soda, or of common salt into the water, the evolution ceased entirely. Re-employing distilled water, the electricity appeared again; on using the common water supplied to London, it was unable to produce it.

2091. Again, using the steam-globe (2076.), and a box-wood tube (2102.) which excites well if the water distilling over from the boiler be allowed to pass with the steam, when I put a small crystal of sulphate of soda, of common salt, or of nitre, or the smallest drop of sulphuric acid, into the steam-globe with the water, the apparatus was utterly ineffective, and no electricity could be produced. On withdrawing such water and replacing it by distilled water, the excitement was again excellent: on adding a very small portion of any of these substances, it ceased; but upon again introducing pure water it was renewed.

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* Messrs. ARMSTRONG and SCHAFHAEUTL have both observed the coincidence of certain sounds or noises with the evolution of the electricity.

2092. Common water in the steam-globe was powerless to excite. A little potash added to distilled water took away all its power; so also did the addition of *any* of those saline or other substances which give conducting power to water.

2093. The effect is evidently due to the water becoming so good a conductor, that upon its friction against the metal or other body, the electricity evolved can be immediately discharged again, just as if we tried to excite lac or sulphur by flannel which was damp instead of dry. It shows very clearly that the exciting effect, when it occurs, is due to water and not to the passing steam.

2094. As ammonia increases the conducting power of water only in a small degree (554.), I concluded that it would not take away the power of excitement in the present case; accordingly on introducing some to the pure water in the globe, electricity was still evolved though the steam of vapour and water was able to redden moist turmeric paper. But the addition of a very small portion of dilute sulphuric acid, by forming sulphate of ammonia, took away all power.

2095. When, in any of these cases, the steam-globe contained water which could not excite electricity, it was beautiful to observe how, on opening the cock which was inserted into the steam-pipe before the steam-globe, fig. 1. (the use of which was to draw off the water condensed in the pipe before it entered the steam-globe), electricity was instantly evolved; yet a few inches further on the steam was quite powerless, because of the small change in the quality of the water over which it passed, and which it took with it.

2096. When a wooden or metallic tube (2076.) was used as the exciting passage, the application of solution of salts to the outside and end of the tube in no way affected the evolution. But when a wooden cone (2077.) was used, and that cone moistened with the solutions, there was no excitement on first letting out the steam, and it was only as the solution was washed away that the power appeared; soon rising, however, to its full degree.

2097. Having ascertained these points respecting the necessity of water and its purity, the next for examination was the influence of the substance against which the stream of steam and water rubbed. For this purpose I first used cones (2077.) of various substances, either insulated or not, and the following, namely, brass, boxwood, beech-wood, ivory, linen, kerseymere, white silk, sulphur, caoutchouc, oiled silk, japanned leather, melted caoutchouc and resin, all became negative, causing the stream of steam and water to become positive. The fabrics were applied stretched over wooden cones. The melted caoutchouc was spread over the surface of a boxwood or a linen cone, and the resin cone was a linen cone dipped in a strong solution of resin in alcohol, and then dried. A cone of wood dipped in oil of turpentine, another cone soaked in olive oil, and a brass cone covered with the alcoholic solution of resin and dried, were at first inactive, and then gradually became negative, at which time the oil of turpentine, olive-oil and resin were found cleared off from the parts struck by the stream of steam and water. A cone of kerseymere, which had been dipped in alcoholic solution of resin and dried two or three times in succession, was very irregular, becoming positive and negative by turns, in a manner difficult to comprehend at first, but easy to be understood hereafter (2113.).

2098. The end of a rod of shell-lac was held a moment in the stream of steam and then brought near a gold-leaf electrometer: it was found excited negative, exactly as if it had been rubbed with a piece of flannel. The corner of a plate of sulphur showed the same effect and state when examined in the same way.

2099. Another mode of examining the substance rubbed was to use it in the shape of wires, threads or fragments, holding them by an insulating handle in the jet, whilst they were connected with a gold-leaf electrometer. In this way the following substances were tried:—

Platinum,
Copper,
Iron,
Zinc,
Sulphuret of copper,
Linen,
Cotton,
Silk,
Worsted,
Wood,
Horse-hair,
Bear's hair,
Flint glass,
Green glass,
Quill,
Ivory,
Shell-lac on silk,
Sulphur on silk,
Sulphur in piece,
Plumbago,
Charcoal,
Asbestus,
Cyanite,
Hæmatite,
Rock-crystal,
Orpiment,
Sulphate of baryta,
Sulphate of lime,
Carbonate of lime,
Fluor-spar.

All these substances were rendered negative, though not in the same degree. This apparent difference in degree did not depend *only* upon the specific tendency to become negative, but also upon the conducting power of the body itself, whereby it gave its charge to the electrometer; upon its tendency to become wet (which is very different, for instance in shell-lac or quill, to that of glass or linen), by which its conducting quality was affected; and upon its size or shape. Nevertheless I could distinguish that bear's hair, quill and ivory had very feeble powers of exciting electricity as compared to the other bodies.

2100. I may make here a remark or two upon the introduction of bodies into the jet. For the purpose of preventing condensation on the substance, I made a platinum wire white-hot by an insulated voltaic battery, and introduced it into the jet: it was quickly lowered in temperature by the stream of steam and water to 212°, but of course could never be below the boiling point. No difference was visible between the effect at the first instant of introduction or any other time. It was always instantly electrified and negative.

2101. The threads I used were stretched across a fork of stiff wire, and the middle part of the thread was held in the jet of vapour. In this case, the string or thread, if held exactly in the middle of the jet and looked at end-ways to the thread, was seen to be still, but if removed the least degree to the right or left of the axis of the stream it (very naturally) vibrated, or rather rotated, describing a beautiful circle, of which the axis of the stream was the tangent: the interesting point was to observe, that when the thread rotated, travelling as it were with the current, there was little or no electricity evolved, but that when it was nearly or quite stationary there was abundance of electricity, thus illustrating the effect of friction.

2102. The difference in the quality of the substances above described (2099.) gives a valuable power of arrangement at the jet. Thus if a metal, glass, or wood tube* (2076.) be used for the steam issue, the boiler is rendered well negative and the steam highly positive; but if a quill tube or, better still, an ivory tube be used, the boiler receives scarcely any charge, and the stream of steam is also in a neutral state. This result not only assists in proving that the electricity is not due to evaporation, but is also very valuable in the experimental inquiry. It was in such a neutral jet of steam and water that the excitation of the bodies already described (2099.) was obtained.

2103. Substances, therefore, may be held either in the neutral jet from an ivory tube, or in the positive jet from a wooden or metal tube; and in the latter case effects occurred which, if not understood, would lead to great confusion. Thus an insulated wire was held in the stream issuing from a glass or metal tube, about half an inch from the mouth of the tube, and was found to be unexcited: on moving it in one direction a little further off, it was rendered positive; on moving it in the other direction, nearer to the tube, it was negative. This was simply because, when near the tube in the forcible part of the current, it was excited and rendered negative, rendering the steam and water more positive than before, but that when further off, in a quieter part of the current, it served merely as a discharger to the current previously excited in the exit tube, and so showed the same state with it. Platinum, copper, string, silk, wood, plumbago, or any of the substances mentioned above (2099.), excepting quill, ivory, and bear's hair, could, in this way, be made to assume either one state or the other, according as they were used as exciters or dischargers, the difference being determined by their place in the stream. A piece of fine wire gauze held across the issuing jet shows the above effect very beautifully; the difference of an eighth of an inch either way from the neutral place will change the state of the wire gauze.

2104. If, instead of an excited jet of steam and water (2103.), one issuing from an ivory tube (2102.), and in the neutral state be used, then the wires, &c. can no longer be made to assume both states. They may be excited and rendered negative (2099.), but at no distance can they become dischargers, or show the positive state.

2105. We have already seen that the presence of a very minute quantity of matter able to give conducting power to the water took away all power of excitation (2090,

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* A box-wood tube, 3 inches long and $\frac{1}{5}$th of an inch inner diameter, well soaked in distilled water and screwed into the steam-globe, is an admirable exciter.

&c.) up to the highest degree of pressure, i. e. of mechanical friction that I used (2086.); and the next point was to ascertain whether it would be so for all the bodies rubbed by the stream, or whether differences in degree would begin to manifest themselves. I therefore tried all these bodies again, at one time adding about two grains of sulphate of soda to the four ounces of water which the steam-globe retained as a constant quantity when in regular action, and at another time adding not a fourth of this quantity of sulphuric acid (2091.). In both cases all the substances (2099.) remained entirely unexcited and neutral. Very probably, great increase of pressure might have developed some effect (2086.).

2106. With dilute sulphuric acid in the steam-globe, varying from extreme weakness to considerable sourness, I used tubes and cones of zinc, but could obtain *no trace* of electricity. Chemical action, therefore, appears to have nothing to do with the excitement of electricity by a current of steam.

2107. Having thus given the result of the friction of the steam and water against so many bodies, I may here point out the remarkable circumstance of water being *positive* to them all. It very probably will find its place above all other substances, even cat's hair and oxalate of lime (2131.). We shall find hereafter, that we have power, not merely to prevent the jet of steam and water from becoming positive, as by using an ivory tube (2102.), but also of reducing its own power when passing through or against such substances as wood, metal, glass, &c. Whether, with a jet so reduced, we shall still find amongst the bodies above mentioned (2099.) some that can render the stream positive and others that can make it negative, is a question yet to be answered.

2108. Advancing in the investigation, a new point was to ascertain what other bodies, than water, would do if their particles were carried forward by the current of steam. For this purpose the feeding apparatus (2078.) was mounted and charged with oil of turpentine, to be let in at pleasure to the steam-exit passage. At first the feeder stop-cock was shut, and the issuing steam and water made the boiler negative. On letting down the oil of turpentine, this state was instantly changed, the boiler became powerfully positive, and the jet of steam, &c. as strongly negative. Shutting off the oil of turpentine, this state gradually fell, and in half a minute the boiler was negative, as at first. The introduction of more oil of turpentine instantly changed this to positive, and so on with perfect command of the phenomena.

2109. Removing the feeder apparatus and using only the steam-globe and a wooden exit tube (2076.), the same beautiful result was obtained. With pure water in the globe the boiler was negative, and the issuing steam, &c. positive; but a drop or two of oil of turpentine, introduced into the steam-globe with the water, instantly made the boiler positive and the issuing stream negative. On using the little interposed chamber C (2079.), the effects were equally decided. A piece of clean new sail-cloth was formed into a ring, moistened with oil of turpentine and placed in the box; as long as a trace of the fluid remained in the box the boiler was positive and the issuing stream negative.

2110. Thus the positive or negative state can be given at pleasure, either to the substance rubbed or to the rubbing stream; and with respect to this body, oil of turpentine, its perfect and ready dissipation by the continuance of the passage of the steam soon causes the new effect to cease, yet with the power of renewing it in an instant.

2111. With olive oil the same general phenomena were observed, i. e. it made the stream of steam, &c. *negative*, and the substance rubbed by it *positive*. But from the comparative fixedness of oil, the state was much more permanent, and a very little oil introduced into the steam-globe (2076.), or into the chamber C (2079.), or into the exit tube, would make the boiler positive for a long time. It required, however, that this oil should be in such a place that the steam stream, after passing by it, should rub against other matter. Thus, on using a wooden tube (2076. 2102.) as the exciter, if a little oil were applied to the inner termination, or that at which the steam entered it, the tube was made positive and the issuing steam negative; but if the oil were applied to the outer termination of the tube, the tube had its ordinary negative state, as with pure water, and the issuing steam was positive.

2112. Water is essential to this excitation by fixed oil, for when the steam-globe was emptied of water, and yet oil left in it and in the passages, there was no excitement. The first effect (2089.), it is true, was one of excitement, and it rendered the boiler positive, but that was an effect due to the water condensed in the passage, combined with the action of the oil. Afterwards, when all was hot, there was no evolution of electricity.

2113. I tried many other substances with the chamber C and other forms of apparatus, using the wet wooden tube (2102.) as the place and substance by which to excite the steam stream. Hog's-lard, spermaceti, bees'-wax, castor-oil, resin applied dissolved in alcohol; these, with olive-oil, oil of turpentine, and oil of laurel, all rendered the boiler positive, and the issuing steam negative. Of substances which seemed to have the reverse power, it is doubtful if there are any above water. Sulphuret of carbon, naphthaline, sulphur, camphor, and melted caoutchouc, occasionally seemed in strong contrast to the former bodies, making the boiler very negative, but on trying pure water immediately after, it appeared to do so quite as powerfully. Some of the latter bodies with oil-gas liquid, naphtha and caoutchoucine, gave occasionally variable results, as if they were the consequence of irregular and complicated effects. Indeed, it is easy to comprehend, that according as a substance may adhere to the body rubbed, or be carried off by the passing stream, exchanging its mechanical action from rubbed to rubber, it should give rise to variable effects; this, I think, was the case with the cone and resin before referred to (2097.).

2114. The action of salts, acids, &c., when present in the water to destroy its effect, I have already referred to (2090, &c.). In addition, I may note that sulphuric ether, pyroxylic spirit, and boracic acid did the same.

2115. Alcohol seemed at the first moment to render the boiler positive. Half alcohol and half water rendered the boiler negative, but much less so than pure water.

2116. It must be considered that a substance having the reverse power of water, but only in a small degree, may be able to indicate that property merely by diminishing the power of water. This diminution of power is very different in its cause to that dependent on increasing the conducting power of the water, as by saline matter (2090.), and yet the apparent effect will be the same.

2117. When it is required to render the issuing steam permanently negative, the object is very easily obtained. A little oil or wax put into the steam-globe (2076.), or a thick ring of string or canvas soaked in wax, or solution of resin in alcohol, and introduced into the box C (2079.), supplies all that is required. By adjusting the application it is easy to neutralize the power of the water, so that the issuing stream shall neither become electric, nor cause that to be electrified against which it rubs.

2118. We have arrived, therefore, at three modes of rendering the jet of steam and water neutral, namely, the use of an ivory or quill tube (2102.), the presence of substances in the water (2090, &c.), and the neutralization of its natural power by the contrary force of oil, resin, &c. &c.

2119. In experiments of the kind just described an ivory tube cannot be used safely with acid or alkalies in the steam-globe, for they, by their chemical action on the substance of the tube, in the evolution or solution of the oily matter for instance, change its state and make its particular power of excitement very variable. Other circumstances also powerfully affect it occasionally (2144.).

2120. A very little oil in the rubbing passages produces a great effect, and this at first was a source of considerable annoyance, by the continual occurrence of unexpected results; a portion may lie concealed for a week together in the thread of an unsuspected screw, and yet be sufficient to mar the effect of every arrangement. Digesting and washing with a little solution of alkali, and avoiding all oiled washers, is the best way in delicate experiments of evading the evil. Occasionally I have found that a passage, which was in some degree persistently negative, from a little melted caoutchouc, or positive from oil, resin, &c., might be cleared out thoroughly by letting oil of turpentine be blown through it; it assumed for a while the positive state, but when the continuance of steam had removed that (2110.), the passage appeared to be perfectly clear and good and in its normal condition.

2121. I now tried the effect of oil, &c. when a little saline matter or acid was added to the water in the steam-globe (2090, &c.), and found that when the water was in such a state as to have no power of itself, still oil of turpentine, or oil, or resin in the box C, showed their power, in conjunction with such water, of rendering the boiler positive, but their power appeared to be reduced: increase of the force of steam, as in all other cases, would, there is little doubt, have exalted it again. When alkali was in the steam-globe, oil and resin lost very much of their power, and oil of turpentine very little. This fact will be important hereafter (2126.).

2122. We have seen that the action of such bodies as oil introduced into the jet of steam changed its power (2108.), but it was only by experiment we could tell whether this change was to such an extent as to alter the electricity for few or many of the bodies against which the steam stream rubbed. With olive oil in the box C, *all* the insulated cones before enumerated (2097.) were made positive. With acetic acid in the steam-globe all were made neutral (2091.). With resin in the box C (2113.), all the substances in the former list (2099.) were made positive, there was not one exception.

2123. The remarkable power of oil, oil of turpentine, resin, &c., when in very small quantity, to change the exciting power of water, though as regards some of them (2112.) they are inactive without it, will excuse a few theoretical observations upon their mode of action. In the first place it appears that steam alone cannot by friction excite the electricity, but that the minute globules of water which it carries with it being swept over, rubbed upon and torn from the rubbed body (2085.) excite it and are excited, just as when the hand is passed over a rod of shell-lac. When olive oil or oil of turpentine is present, these globules are, I believe, virtually converted into globules of these bodies, and it is no longer water, but the new fluids which are rubbing the rubbed bodies.

2124. The reasons for this view are the following. If a splinter of wood dipped in olive oil or oil of turpentine touch the surface of water, a pellicle of the former instantly darts and spreads over the surface of the latter. Hence it is pretty certain that every globule of water passing through the box C, containing olive oil or oil of turpentine, will have a pellicle over it. Again, if a metal, wooden, or other balance-pan be *well cleaned* and *wetted* with water, and then put on the surface of clean water in a dish, and the other pan be loaded until almost, but not quite able to pull the first pan from the water, it will give a rough measure of the cohesive force of the water. If now the oily splinter of wood touch any part of the clean surface of the water in the dish, not only will it spread over the whole surface, but cause the pan to separate from the water, and if the pan be put down again, the water in the dish will no longer be able to retain it. Hence it is evident that the oil facilitates the separation of the water into parts by a mechanical force not otherwise sufficient, and invests these parts with a film of its own substance.

2125. All this must take place to a great extent in the steam passage: the particles of water there must be covered each with a film of oil. The tenuity of this film is no objection to the supposition, for the action of excitement is without doubt at that surface where the film is believed to exist, and such a globule, though almost entirely water, may well act as an oil globule, and by its friction render the wood, &c. positive, itself becoming negative.

2126. That water which is rendered ineffective by a little saline or acid matter should still be able to show the effect of the film of oil (2121.) attached to it, is perfectly consistent with this view. So also is the still more striking fact that alkalized water (2092.) having no power of itself should deeply injure the power of olive oil or resin, and hardly touch that of oil of turpentine (2121.), for the olive oil or resin would no longer form a film over it but dissolve in it, on the contrary the oil of turpentine would form its film.

2127. That resin should produce a strong effect and sulphur not is also satisfactory, for I find resin in boiling hot water melts, and has the same effect on the balance (2124.) as oil, though more slowly; but sulphur has not this power, its point of fusion being too high.

2128. It is very probable that when wood, glass, or even metal is rubbed by these oily currents, the oil may be considered as rubbing not merely against wood, &c., but water also, the water being now on the side of the thing rubbed. Under the circumstances water has much more attraction for the wood rubbed than oil has, for in the steam-current, canvas, wood, &c. which has been well soaked in oil for a long time are quickly dispossessed of it, and found saturated with water. In such case the effect would still be to increase the positive state of the substance rubbed, and the negative state of the issuing stream.

2129. Having carried the experiments thus far with steam, and having been led to consider the steam as ineffectual by itself, and merely the mechanical agent by which the rubbing particles were driven onwards, I proceeded to experiment with compressed air*. For this purpose I used a strong copper box of the capacity of forty-six cubic inches, having two stop-cocks, by one of which the air was always forced in, and the other retained for the exit aperture. The box was very carefully cleaned out by caustic potash. Extreme care was taken (and required) to remove and avoid oil, wax, or resin about the exit apertures. The air was forced into it by a condensing syringe, and in certain cases when I required dry air, four or five ounces of cylinder potassa fusa were put into the box, and the condensed air left in contact with the substance ten or fifteen minutes. The average quantity of air which issued and was used in each blast was 150 cubic inches. It was very difficult to deprive this air of the smell of oil which it acquired in being pumped through the condensing syringe.

2130. I will speak first of undried common air: when such compressed air was let suddenly out against the brass or the wood cone (2077.), it rendered the cone negative, exactly as the steam and water had done (2097.). This I attributed to the particles of water suddenly condensed from the expanding and cooled air rubbing against the metal or wood: such particles were very visible in the mist that appeared, and also by their effect of moistening the surface of the wood and metal. The electricity here excited is quite consistent with that evolved by steam and water: but the idea of that being due to evaporation (2083.) is in striking contrast with the actual condensation here.

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* Mr. ARMSTRONG has also employed air in much larger quantities. Philosophical Magazine, 1841, vol. xviii. pp. 133, 328.

2131. When however common air was let out against ice it rendered the ice *positive*, again and again, and that in alternation with the negative effect upon wood and metal. This is strongly in accordance with the high positive position which has already been assigned to water (2107.).

2132. I proceeded to experiment with dry air (2129.), and found that it was in all cases quite *incapable* of exciting electricity against wood or sulphur, or brass, in the form of cones (2077. 2097.); yet if, in the midst of these experiments, I let out a portion of air immediately after its compression, allowing it no time to dry, then it rendered the rubbed wood or brass negative (2130.). This is to me a satisfactory proof that in the former case the effect was due to the condensed water, and that neither *air alone* nor *steam alone* can excite these bodies, wood, brass, &c., so as to produce the effect now under investigation.

2133. In the next place the box C was attached to this air apparatus and experiments made with different substances introduced into it (2108.), using common air as the carrying vehicle.

2134. With distilled water in C, the metal cone was every now and then rendered negative, but more frequently no effect was produced. The want of a continuous jet of air sadly interfered with the proper adjustment of the proportion of water to the issuing stream.

2135. With common water (2090.), or a very dilute saline solution, or very dilute sulphuric acid (2091.) or ammonia, I never could obtain any traces of electricity.

2136. With oil of turpentine only in box C, the metal cone was rendered positive; but when both distilled water and oil of turpentine were introduced, the cone was very *positive*, indeed far more so than before. When sent against ice, the ice was made positive.

2137. In the same manner olive oil and water in C, or resin in alcohol and water in C, rendered the cone positive, exactly as if these substances had been carried forward in their course by steam.

2138. Although the investigation as respects the steam stream may here be considered as finished, I was induced in connection with the subject to try a few experiments with the air current and dry powders. *Sulphur* in powder (sublimed) rendered both metal and wood, and even the sulphur cone negative, only once did it render metal positive. *Powdered resin* generally rendered metal negative, and wood positive, but presented irregularities, and often gave *two states in the same experiment*, first diverging the electrometer leaves, and yet at the end leaving them uncharged. *Gum* gave unsteady and double results like the resin. *Starch* made wood negative. *Silica*, being either very finely powdered rock-crystal or that precipitated from fluo-silicic acid by water, gave very constant and powerful results, but both metal and wood were made strongly positive by it, and the silica when caught on a wet insulated board and examined was found to be negative.

2139. These experiments with powders give rise to two or three observations. In the first place the high degree of friction occurring between particles carried forward by steam or air was well illustrated by what happened with sulphur: it was found driven into the dry box-wood cone opposed to it with such force that it could not be washed or wiped away, but had to be removed by scraping. In the next place, the *double* excitements were very remarkable. In a single experiment, the gold leaves would open out very wide at first, and then in an instant as suddenly fall, whilst the jet still continued, and remains at last either neutral or a very little positive or negative: this was particularly the case with gum and resin. The fixation upon the wood of some of the particles issuing at the beginning of the blast and the condensation of moisture by the expanding air, are circumstances which with others present tend to cause these variable results.

2140. Sulphur is nearly constant in its results, and silica very constant, yet their states are the reverse of those that might have been expected. Sulphur in the lump is rendered negative whether rubbed against wood or any of the metals which I have tried, and renders them *positive* (2141.), yet in the above experiments it almost always made both negative. Silica, in the form of a crystal, by friction with wood and metals renders them *negative*, but applied as above, it constantly made them strongly positive. There must be some natural cause for these changes, which at present can only be considered as imperfect results, for I have not had time to investigate the subject.

2141. In illustration of the effect produced by steam and water striking against other bodies, I rubbed these other substances (2099.) together in pairs to ascertain their order, which was as follows:—

1. Catskin or bearskin.
2. Flannel.
3. Ivory.
4. Quill.
5. Rock-crystal.
6. Flint glass.
7. Cotton.
8. Linen, canvas.
9. White silk.
10. The hand.
11. Wood.
12. Lac.
13. Metals . . .
    - Iron.
    - Copper.
    - Brass.
    - Tin.
    - Silver.
    - Platinum.
14. Sulphur.

Any one of these became negative with the substances above, and positive with those beneath it. There are however many exceptions to this general statement: thus one part of a catskin is very negative to another part, and even to rock-crystal: different pieces of flannel also differ very much from each other.

2142. The mode of rubbing also makes in some cases a great difference, although it is not easy to say why, since the particles that actually rub ought to present the same constant difference; a feather struck lightly against dry canvas will become strongly negative, and yet the same feather drawn with a little pressure between the folds of the same canvas will be strongly positive, and these effects alternate, so that it is easy to take away the one state in a moment by the degree of friction which produces the other state. When a piece of flannel is halved and the two pieces drawn across each other, the two pieces will have different states irregularly, or the same piece will have both states in different parts, or sometimes both pieces will be negative, in which case, doubtless, air must have been rendered positive, and then dissipated.

2143. Ivory is remarkable in its condition. It is very difficult of excitement by friction with the metals, much more so than linen, cotton, wood, &c., which are lower in the scale than it (2141.), and withal are much better conductors, yet both circumstances would have led to the expectation that it would excite better than them when rubbed with metals. This property is probably very influential in giving character to it as a non-exciting steam passage (2102.).

2144. Before concluding this paper, I will mention, that having used a thin ivory tube fixed in a cork (2076.) for many experiments with oil, resin, &c., it at last took up such a state as to give not merely a non-exciting passage for the steam, but to exert upon it a nullifying effect, for the jet of steam and water passing through it produced no excitation against any of the bodies opposed, as on the former occasion, to it (2099.). The tube was apparently quite clean, and was afterwards soaked in alcohol to remove any resin, but it retained this peculiar state.

2145. Finally, I may say that the cause of the evolution of electricity by the liberation of confined steam is not evaporation; and further, being, I believe, friction, it has no effect in producing, and is not connected with, the general electricity of the atmosphere: also, that as far as I have been able to proceed, pure gases, *i. e.* gases not mingled with solid or liquid particles, do not excite electricity by friction against solid or liquid substances*.

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* References to papers in the Philosophical Magazine, 1840–1843. ARMSTRONG, Phil. Mag. vol. xvii. pp. 370, 452; vol. xviii. pp. 50, 133, 328; vol. xix. p. 25; vol. xx. p. 5; vol. xxii. p. 1. PATTINSON, Phil. Mag. vol. xvii. pp. 375, 457. SCHAFHAEUTL, Phil. Mag. vol. xvii. p. 449; vol. xviii. pp. 14, 95, 265.

PLATE I.

Description of the Apparatus represented in section, and to a scale of one-fourth.

Fig. 1. The steam-globe (2076.), principal steam-cock, and drainage-cock to remove the water condensed in the pipe. The current of steam, &c. travelled in the direction of the arrow-heads.

Fig. 2. The cone apparatus (2077.) in one of its forms. The cone could be advanced and withdrawn by means of the milled head and screw.

Fig. 3. The feeding apparatus (2078.). The feeder was a glass tube or retort neck fitted by a cork into the cap of the feeding stop-cock. Other apparatus, as that figured 2, 5, 6, could be attached by a connecting piece to this apparatus.

Fig. 4. The chamber C (2079.) fitted by a cork on to a metal pipe previously screwed into the steam-globe; and having a metallic tube and adjusting piece screwed into its mouth. Other parts, as the cone fig. 2, or the wooden or glass tubes 5, 6, could be conjoined with this chamber.

Fig. 5. The box-wood tube (2102.).

Fig. 6. A glass or thin metal tube (2076.) attached by a cork to a mouth-piece fitting into the steam-globe.

IV. *Spermatozoa observed within the Mammiferous Ovum.*

By Martin Barry, *M.D., F.R.SS. L. and E.*

Received November 24,—Read December 8, 1842.

As the results of my researches in Embryology have all been communicated to the Royal Society*, it seems proper to offer to its notice a single observation which I have lately made.

On a former occasion† I stated that at certain periods an orifice was sometimes visible in the thick transparent membrane ("*zona pellucida*") of the mammiferous ovum; and that once I had seen an object very much resembling a spermatozoon in the orifice. But spermatozoa, so far as I am aware, have never been described as seen *within* the ovum of any animal. It may therefore be interesting to physiologists to be informed that about a fortnight since, in examining some ova of the Rabbit of twenty-four hours, from the Fallopian tube,—in which the orifice above-mentioned was no longer visible,—I unexpectedly discerned a number of spermatozoa in their interior. These ova were submitted to the inspection of Professor Owen, and I afterwards showed one of them to Professors Sharpey and Grainger, all of whom agreed that the spermatozoa were *contained within the ovum*‡.

London, 21*st November*, 1842.

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* Philosophical Transactions, 1838-39-40-41.

† Ibid. 1840, p. 533.

‡ [The ova were in that state in which the essential part—the germ—consists of two cells. The spermatozoa lay around and between these cells; and when the ova were first examined I thought I discerned traces of spermatozoa even *within* the cells.

While the paper is going through the press, the opportunity is afforded me for mentioning that I have this day confirmed the observation above recorded; several ova from the Fallopian tube of another rabbit, in a somewhat earlier stage, having presented spermatozoa in their interior;—i. e. (as in the first observation) within the thick transparent membrane ("*zona pellucida*") brought with the ovum from the ovary.—31st March, 1843.]

V. *Observations on certain cases of Elliptic Polarization of Light by Reflexion. By the Rev.* **Baden Powell**, *M.A., F.R.S., F.G.S., F.R.A.S., Savilian Professor of Geometry in the University of Oxford.*

Received November 10, 1842,—Read January 26, 1843.

Introduction.

THE peculiar character impressed on light, originally polarized in a plane inclined to that of incidence and reflected from a metallic surface, discovered by Sir D. Brewster*, and named by him elliptic polarization, has been since shown to coincide with what, from a different analogy, is termed elliptic polarization in the undulatory theory; and which is also exhibited by an interposed plate of mica, or by total internal reflexion, as in Fresnel's rhomb.

The most distinct experimental test of the existence of this property and a measure of its amount, is the well-known *dislocation* of the polarized rings, seen by a plate of calc-spar and a tourmaline, in light of this kind. And this, as in other similar cases, is represented theoretically by a formula for the intensity at any part of the plate, *in the case of the rhomb*, for *circular* polarization, as in Mr. Airy's tract on the undulatory theory (Art. 160.); and for *elliptic*, as in the same author's paper on quartz†. A general formula for the rings in light of all degrees of ellipticity, *not* restricted by the peculiar conditions of the *rhomb*, has not been hitherto published: but I am indebted to Mr. Airy for the communication of such a formula, which will be given in the sequel, as leading to some remarkable applications.

With immediate reference to the experiments of Sir D. Brewster *on thin films*‡, Professor Lloyd, in 1841, investigated on the principles of the undulatory theory, the general case of light previously polarized in any azimuth, and reflected from a thin plate, at any angle; and by generalizing the methods of M. Poisson, found expressions both for the intensity, the changes corresponding to different incidences, and the phase of vibration of the pencils reflected from the two surfaces, which in general differ in retardation and are polarized, one in the plane of reflexion and the other perpendicular to it: whence it follows that the resulting light should be in general *elliptically polarized*§.

Professor Lloyd's theory seems completely to explain the various phenomena observed by Sir D. **Brewster**, including those of Mr. **Airy**[*] on the colours of thin plates in polarized light. But Professor **Lloyd** also infers the further application of the same principles to the case of elliptic polarization in the reflexion from polished metals, on the hypothesis that their superficial laminæ may be regarded as thin plates, or at least act in an analogous manner.

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* Philosophical Transactions, 1830.

† Cambridge Transactions, 1831.

‡ Philosophical Transactions, 1840.

§ See Reports of British Association, 1841, Sectional Proceedings, p. 26.

Before I was acquainted with Professor **Lloyd**'s *theoretical* investigations, I had pursued an *experimental* examination of the phenomena of elliptic polarization in the reflexion from various surfaces, in the course of which I was led to some cases which seem to have a more special bearing upon theory, particularly in connexion with the views just referred to.

My observations were all conducted by the method of observing the modifications of the polarized rings under different conditions, both of surface and of incidence; and were directed to ascertaining both the *existence* and *amount* of ellipticity shown by the dislocation of those rings, as also to the peculiar character indicated by the *direction* in which the dislocation takes place; the protrusion of the alternate quadrants appearing in certain cases in one direction and in others in the opposite.

The observations are reducible to two classes:—1st, those designed to contribute to the inquiry *what substances* possess the property of elliptic polarization?, by examining the light reflected from various bodies; of which I here notice only a few cases which appeared remarkable; 2ndly, observations on certain cases of *films* of several kinds, including those formed on metal by oxidation, or other action upon the metal itself, as well as by extraneous deposition. In these cases the ellipticity generally exists in different degrees, and with different characters as to direction, while in some instances it is destroyed or reduced to plane polarization.

I at first noticed these effects as produced in some cases of highly polished metal which had become tarnished by long exposure, and in which iridescent films had formed on the surface without destroying the polish. And again, in trying the effect of *heating* a metal plate, while observing the rings, I found the ellipticity disappear, but soon perceived that the effect was due to the coloured films formed on the surface, and remained when the plate was cold. I was thus led to institute more exact experiments of the same kind, in which the tints were formed in regular succession, as well as to examine steel in different stages of tempering.

From these cases I was naturally led to those of the films of metallic deposit produced by the galvanic process of **Nobili**; specimens of which were kindly furnished me by Dr. **Daubeny**. In these films it is well known the colours follow, at least generally, the orders of **Newton**'s scale; the thickest film being deposited where the action is most intense, or where the surfaces in connexion with the two poles most nearly approach one another. In all these instances, then, I had a succession of films formed upon metal, in which the changes effected in the polarization could be traced in regular order.

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[*] Cambridge Transactions, 1832.

The general result in all these cases, is that, *from any one tint to another, through each entire order of tints, the form of the rings in the reflected light undergoes certain regular changes, passing from a dislocation in one direction, to that in the opposite, through an intermediate point of no dislocation, or of plane polarization: and this, exhibiting a dark and a bright centred system alternately, as long as the orders of tints are preserved pure.*

Now these are precisely the changes in the form of the rings expressed by successive modifications of Mr. Airy's formula, corresponding to the increments in the retardation which belong to the periodical colours of the films.

In the instance of the metallic films it is a question whether in any case the existence of elliptic polarization be due to the action of the film simply, or whether the subjacent metallic surface have any share in producing it, while the film acts as a retarding plate, which would render the conception of the mode of action more complex.

These are points on which, perhaps, at present we cannot form a decisive opinion. But the fact that the ellipticity, to whatever cause it may be due, undergoes the changes just mentioned, affords an interesting comparison with theory, and may aid future advances towards a knowledge of the nature of the action which produces elliptic polarization in these cases.

Apparatus and Method of experimenting.

The arrangement of my apparatus was, essentially, as follows: the light was polarized by transmission through a Nicol-prism; this was attached to a small graduated arc, so that it could be adjusted to throw the polarized ray at any required incidence on the surface under examination; and could be turned about its own axis, so that the plane of polarization might be inclined to that of incidence.

After reflexion, the ray was received by an analysing apparatus, containing a plate of calc-spar and a tourmaline, capable of a corresponding adjustment to different inclinations, by which were exhibited the polarized rings in the several modifications they underwent in different cases. This part had also a motion about its own axis, measured by a graduated circle. It will hardly be necessary to state more details as to the construction of the apparatus, except perhaps to observe that an arrangement, by which the surface under examination could be slid horizontally under the polarizing apparatus, was necessary when the object was to examine the changes presented in passing from one part of some surfaces to another.

In many cases where the reflexion from parts of a surface of varying character was to be examined, I fitted to the eye-piece a lens of short focus, between the calc-spar and the reflecting surface, which enabled me to see with great distinctness the rings in light from very small portions of the surface, which could be isolated by covering the rest.

In all cases the analyser is supposed in the position to give the dislocated rings with the nearest approach to the dark cross with the plain metal; the circular systems alone being precisely described as dark or bright centred.

The direction of dislocation is distinguished by the quadrants in which the dark patches near the centre occur. The position of the line joining them, upon plain metal, is taken as the zero for comparison in other cases.

The observations were repeated at several different incidences, but for the purpose of the comparisons here in view, it suffices to give the results at one incidence, the relative appearances at others being similar. They are arranged in a tabular form in each case.

Observations.—Professor FORBES'S *Mica.*

The original observations of Sir D. BREWSTER were confined to pure metals and a few metallic ores; in all which the ellipticity is insensible at incidences less than about 30°, and comes to a maximum at between 70° and 80°.

Besides these, as far as I am aware, the only instance is that announced by Professor FORBES* of elliptic polarization in the reflexion from mica when reduced to the particular state in which he used it for his experiments on heat.

On repeating the experiment I observed that it has its maximum at an incidence between 20° and 30°, and the direction of dislocation, 90°. But the films thus formed do not lose their crystalline structure or retarding property: it may therefore be doubtful how far the effect may be explicable in the ordinary way.

Decomposed Glass.

In some specimens of glass, whose surface is in a well-known peculiar state of decomposition, not only iridescent, but having a singularly metallic lustre, I found elliptic polarization, though none was perceptible in other specimens, however highly iridescent, which had not the metallic appearance. There are, however, anomalies with other metallic reflexion, for the maximum effect appears at *small* incidences (about 30° or 40°), and the direction of dislocation is 90°.

Minerals, &c.

Among a variety of metallic ores, I have found elliptic polarization produced only by a few having a decided metallic lustre. What proportion of metal may be necessary to give ellipticity, is an interesting question for future research. But one remarkable instance is that of *plumbago*, which gives a small though distinct ellipticity; while its composition is well known to be doubtful: but on the highest estimate it contains 95 of carbon to 5 of iron†.

In some ores exhibiting a natural iridescence, the results seem analogous to those about to be described in artificial surfaces of this kind.

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* British Association, 1839, Sectional Proceedings, p. 6.

† THOMSON'S Chemistry, i. 396. 6th Ed.

Oxidation.

The common effect of oxidation is to reduce the elliptic into plane polarization. This is the case with the oxidation produced on copper, &c. by a drop of dilute acid, and with the dull tarnished surface of most metals after long exposure.

A transparent film on the surface of polished metal may diminish or destroy the ellipticity, obviously from its refraction causing the rays to fall on the metal beneath at too small an angle.

Mercury, when pure, gives a large elliptic polarization; and even when the surface is coated with the film of oxide which so readily forms upon it, the ellipticity remains unaltered: the surface of the oxide, however, has a sort of metallic appearance.

Daguerreotype Plates.

With one of these plates on which a picture had been formed, at incidences of 60° and 70°, I could perceive no difference in the degree of ellipticity, or direction of dislocation, between those parts of the surface which remained bright, and those which had been most powerfully acted upon.

Tempered Steel.

With reference to the same objects I tried plates of steel in its ordinary state, and in two stages of tempering, viz. the yellow or straw-coloured, and the blue. The former is well known to be that formed at the lowest heat. The film or state of surface thus produced occasions changes both in the amount and direction of the dislocation.

Dr. THOMSON*, in describing the process of tempering, observes that it is a question whether the changes in colour be due to thin plates of an oxide simply, or whether there may not be different oxides produced in succession.

This last opinion agrees with the nature of my results, as well as with the absence of change of colour on altering the inclination. The results are as follows:—

Incidence.	Surface.	Polarization.	Centre.	Direction of dislocation.
70°	Steel, plain	Elliptic, large	....	0°
	Steel, tempered.			
	Yellow......	Elliptic, very small, or none	Dark...	0°
	Blue..........	Very small........	Dark...	90°

Coloured Films on Steel by Heat.

To examine the phenomena more precisely in their order of succession, I formed coloured films on plates of highly polished steel, about five inches square, by applying to the under side, at the centre, the flame of a spirit-lamp, when colours soon began to appear on the upper surface, and assumed the form of rings round the point of application of the heat.

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* Chem. i. 386. 6th Ed.

Each tint appeared in succession, first at the centre, and thence extended itself. The first tints succeeded each other in the course of a few seconds; but the latter more slowly; until at length, after the heat had been continued for a considerable time, no further change took place.

The tints, proceeding in order from the outermost to the centre, may be described and grouped as follows:—

1. Reddish brown, crimson, deep purple, dark blue, light blue, faint yellow.
2. Faint red, light blue, pale reddish brown (at the centre).

The last two colours were very faint, and seemed covered with a sort of cloudy whiteness.

It is difficult to compare these tints with any part of Newton's scale: but I have here grouped them in two divisions which seem clearly marked by a periodicity, while in the last two tints a peculiar character appears to prevail.

The supposition of a change in the degree of oxidation before referred to, seems to accord with the peculiar appearance of the later tints, while the periodicity of the former agrees with the supposition of thin plates up to that point.

In the observed phenomena of ellipticity there appear distinctions corresponding to the *regular* orders of tints; for in passing them in succession under the apparatus, corresponding changes in the amount and direction of dislocation occur, as far as the red of the 2nd set; while in the remaining part, the ellipticity is greatly diminished, and no change in direction takes place.

The figures 1, 2, &c. distinguish successive parts of each coloured space at which the changes occur.

Incidence.	Surface.	Polarization.	Centre.	Direction of dislocation.
70°	Steel, plain	Elliptic, large.		0°
	Films by heat.			
	1st Red	Elliptic, large		0°
	Blue 1	Plane	Bright.	
	Blue 2	Elliptic, large		90°
	Yellow	Plane	Dark.	
	2nd Red	Elliptic, large		0°
	Blue, &c.	Small	Dark	0°

Coloured Films on Copper by Heat.

I formed colours in exactly the same way on plates of copper of the same size. The tints here do not appear exactly the same as those on steel, though there is some general correspondence: they follow this order, commencing from the outermost.

1st. Red, purple, pale yellow, yellow.

2nd. Red, green, dull brown.

The last two tints have a sombre appearance, different from the metallic lustre of the others: this (as in the last case) may accord with the supposition of a different degree of oxidation.

Here also I find similar changes in the ellipticity through the first tints, but none in the last two.

Incidence.	Surface.	Polarization.	Centre.	Direction of dislocation.
70°	Copper, plain ..	Elliptic, large.	....	0°
	Films by heat.			
	1st Red	Elliptic, large	....	0°
	Purple........	Plane............	Bright.	
	Yellow.... 1	Elliptic, large	....	90°
	Yellow.... 2	Plane............	Dark.	
	2nd Red	Elliptic, large	....	0°
	Green, &c.	Small............	Dark ..	0°

Nobili's *Coloured Films.*

Besides furnishing me with several specimens of these films on steel plates, in which very brilliant tints were developed as far as the 3rd order, Dr. Daubeny kindly caused other plates to be prepared in his laboratory, in order to trace the order of the effects produced.

In forming one of these, the process was continued longer than before, and thus a 4th order of very faint colours succeeded. In another instance the process was continued still longer, and colours were formed which went through the same series as before, but at the 4th order they became extremely dusky and obscure; and the 5th order was barely visible from increasing opacity. They followed one another in succession towards the circumference, where they were at length crowded together, forming a narrow fringe, within which the central space was of a deep brown or black, of a dull, opake, appearance; and when this had occurred, the galvanic action being kept up for some time afterwards, no further change took place.

It can hardly be doubted that the increasing dulness in the later orders of tints, and final opacity of the film, are due to some change in the nature of the deposit which is superinduced at this stage of the process.

On bringing the coloured parts of the plate successively under the apparatus, the changes in the rings were clearly marked through the three orders of tints; though they followed in very close succession, commencing upon the edge of the film; and in the passage through the bright-centred system the variations of colour were striking, and at first somewhat perplexing.

The following general results were derived from repeated observations with different plates compared together.

Incidence.	Surface.			Polarization.	Centre.	Direction of dislocation.
70°	Steel, plain			Elliptic large	....	0°
	Nobili's films.					
	First order	yellow	1	Elliptic, large	....	90
			2	Plane	Dark.	
		red	3	Elliptic, large	....	0
			4	Plane	Bright.	
	Second order	green	1	Elliptic, large	....	90
			2	Plane	Dark.	
		red	3	Elliptic, large	....	0
			4	Plane	Bright.	
	Third order	green	1	Elliptic, large	....	90
			2	Plane	Dark.	
		red	3	Elliptic, large	....	0
			4	Plane	Bright.	
	Fourth order	green		Elliptic, small	Dark.	0
		red		Elliptic, very small	Dark.	0
	Black			Elliptic, very small, or none	Dark.	0

Analytical Investigation.

Mr. Airy's general formula is investigated as follows:—

In the usual notation of the undulatory theory, we suppose a vibration in a plane P, represented by

$$a \sin \frac{2\pi}{\lambda}(v t - x)$$

incident on a metallic surface, so that P is inclined 45° to the plane of reflexion R. Then (the vibration perpendicular to R being accelerated in phase by ϱ) the resolved parts are

$$\frac{a}{\sqrt{2}} \sin \frac{2\pi}{\lambda}(v t - x) \text{ . . . . in R.}$$

$$\frac{a}{\sqrt{2}} \sin \frac{2\pi}{\lambda}(v t - x + \varrho) \text{ . . perpendicular to R.}$$

Then for a plane Q in the crystallized plate inclined to R by an angle φ (omitting the constant coefficient) the vibration perpendicular to Q, giving the ordinary ray, O, will be

$$\sin\left(\frac{2\pi}{\lambda}(v t - x + \varrho)\right)\cos\varphi - \sin\frac{2\pi}{\lambda}(v t - x)\sin\varphi = \text{O},$$

and that in Q giving the extraordinary ray E will be

$$\sin\left(\frac{2\pi}{\lambda}(v t - x + \varrho)\right)\sin\varphi + \sin\frac{2\pi}{\lambda}(v t - x)\cos\varphi = \text{E}.$$

But on emergence from the crystallized plate the latter is accelerated by θ (dependent on the thickness traversed), or it becomes

$$\sin\varphi \sin\left(\frac{2\pi}{\lambda}(v\,t - x + \varrho) + \theta\right) + \cos\varphi \sin\left(\frac{2\pi}{\lambda}(v\,t - x) + \theta\right) = \mathrm{E}'.$$

The parts remaining after analysation in a plane A perpendicular to P will then be,

$$\mathrm{O}\cos(45 - \varphi) - \mathrm{E}'\sin(45 - \varphi).$$

These upon expansion are at length reducible to the form

$$\mathrm{H}\sin\frac{2\pi}{\lambda}(v\,t - x) \quad + \mathrm{K}\cos\frac{2\pi}{\lambda}(v\,t - x),$$

whence, after reduction, we obtain

$$\mathrm{H}^2 + \mathrm{K}^2 = 1 - \sin^2 2\varphi\cos\varrho - \cos 2\varphi\sin\varrho\sin\theta - \cos^2 2\varphi\cos\varrho\cos\theta,$$

which expresses the intensity of light at any part of the rings, assigned by φ and θ; and is susceptible of variations according to the value of ϱ, or the changes in retardation which may arise from differences in the nature of the metallic films, as in the following Table:—

Values of ϱ.	Expression for the intensity: θ given.					Nature of the rings.
	For φ in general.	$\varphi = \begin{cases}0\\180^\circ.\end{cases}$	$\begin{cases}45^\circ.\\225^\circ.\end{cases}$	$\begin{cases}90^\circ.\\270^\circ.\end{cases}$	$\begin{cases}135^\circ.\\315^\circ.\end{cases}$	
0	$1 - \sin^2 2\varphi - \cos^2 2\varphi\cos\theta$	$1 - \cos\theta$ . .	0	$1 - \cos\theta$ . .	0	Dark-centred, circular.
$\frac{\pi}{2}$	$1 - \cos 2\varphi\sin\theta$	$1 - \sin\theta$ . .	1	$1 + \sin\theta$ . .	1	Dislocated (1).
π	$1 + \sin^2 2\varphi + \cos^2 2\varphi\cos\theta$	$1 + \cos\theta$ . .	2	$1 + \cos\theta$ . .	2	Bright-centred, circular.
$\frac{3\pi}{2}$	$1 + \cos 2\varphi\sin\theta$	$1 + \sin\theta$ . .	1	$1 - \sin\theta$ . .	1	Dislocated opposite way to (1).
2π	$1 - \sin^2 2\varphi - \cos^2 2\varphi\cos\theta$	$1 - \cos\theta$ . .	0	$1 - \cos\theta$ . .	0	Dark-centred, circular.
&c.	&c.	&c.	&c.	&c.	&c.	&c.

These changes will accord with those observed through one order of tints, if the increase of ϱ from 0 to 2π correspond to an increment of one wave length, or if $\varrho = \frac{2\pi k}{\lambda}$ and k be made successively $= 0$, $\frac{\lambda}{4}$, $\frac{\lambda}{2}$, &c.

VI. *On the Laws of Individual Tides at Southampton and at Ipswich.*

By G. B. Airy, *Esq., M.A., F.R.S., Astronomer Royal.*

Received February 16,—Read March 2, 1843.

WITH the view of verifying the reported peculiarity in the tides at Southampton, I had proposed in the month of February 1842 to proceed thither for the purpose of examining, with my own eyes, the rise and fall of the water during one or more tides. As soon, however, as my purpose was made known to Colonel Colby, R.E., Director of the Trigonometrical Survey, and to Lieutenant Yolland, R.E., the Resident Officer at the Ordnance Map Office, Southampton, I received from those gentlemen the offer of placing at my service, for these observations, non-commissioned officers and privates of the corps of Royal Sappers and Miners, as well as of preparing and fixing the vertical scale of feet and inches, and of keeping a watch upon the general accuracy of the observed times. I was extremely glad to avail myself of this offer, for I believe that a more intelligent and faithful body of men does not exist than the Sappers employed in the Trigonometrical Survey; and I knew well the advantage of employing, upon a tedious business like this, a set of regular-service men stationed on the spot.

A vertical scale of deal laths, upon which the divisions and figures were branded, was fixed near the end of the pier at Southampton, very near to the landing-stairs on the north side of the pier, so that the divisions could at all stages of the tide (with the assistance of a lantern at night) be easily read by a person standing on the stairs. The order of the graduations of the scale was increasing from the bottom upwards, and the zero of the scale was found, by levelling, to bear the following relation to certain fixed marks:—

[The mark in each case, except that of St. Paul's Church, is a horizontal cut, indicated by the point of an arrow. The arrow is on one side of the mark at Holyrood Church, and below each of the others.]

The zero of the scale is,

	feet.
Below a mark cut on the metal of the coat of arms on the north side of the pedestal of Chamberlayne's column, Watergate Quay	25·765
Below the ground at the same place	21·990
Below a mark cut in the stone jamb on the south side of the centre door of Holyrood Church	36·310
Below the floor of the portico	33·370

	feet.
Below a mark on the coin stone at the south-west angle of All Saints' Church	43·057
Below the flags of the footpath	37·657
Below a mark on the north side of the pedestal which supports the east lion at the north side of the Bar	50·514
Below the ground there	45·094
Below a mark in the bricks of the wall at the south-west side of the door of the toll-house, at the junction of the London and Salisbury roads	69·669
Below the ground there	67·219
Below the lower sill of the centre door of St. Paul's Church	77·814
Below the flag-stones	76·704
Below a mark on the south front of the west angle of the east wing of the buildings at the Ordnance Map Office	89·344
Below the ground there	87·449

The height of the water upon this scale was observed at every five minutes, from February 23, 15^{h} 10^{m} (astronomical reckoning), to February 27, 6^{h} 20^{m}. The watch by which the times were taken was a pocket chronometer belonging to Lieutenant YOLLAND, of which the error was small. The observations at February 24, 6^{h} 5^{m} and 6^{h} 10^{m}, were omitted from inadvertence (darkness coming on before proper preparations were made); those of February 24, 6^{h} 35^{m} and 6^{h} 40^{m}, were excluded from calculation, because the water was disturbed by a boat; and those of February 25, 2^{h} 0^{m}, 2^{h} 5^{m}, and 2^{h} 10^{m}, because they were evidently irregular, although no reason was assigned for their irregularity.

When the seven complete tides embraced by these observations were laid down in graphical projection, each of them presented a curve similar in its general form to the extraordinary figure represented in the diagram, fig. 1. in Plate II.; four of the curves having three maxima of elevation in each tide. In the first two tides, the first maximum, as in the diagram fig. 1, was rather a stand-still in the rise than a rise and fall; and in the last tide (the highest of all), the first and third maxima were both of this character. In all the others, the three maxima to each tide were well marked.

On February 24, from 15^{h} to 17^{h}, the wind blew strong from W. and S.W. On February 25, from 18^{h} to 19^{h}, it blew a gale from S.W. and W. From February 25, 21^{h}, to February 26, 3^{h}, the wind was strong from S.W. and W. And from February 26, 20^{h} to 23^{h}, there was a strong W.S.W. wind. At other times the air was almost perfectly calm. These changes in the state of the atmosphere do not appear to have produced any sensible alteration in the character of the individual tides.

The epochs and magnitudes of the tides appear, however, to have been sensibly altered by these or other disturbing causes. Thus, if we examine the times and intervals of high water, they are as follows:—

	h	m		h	m
February 23.	22	5			
			Interval	12	30
24.	10	35			
				12	20
24.	22	55			
				12	30
25.	11	25			
				12	10
25.	23	35			
				12	25
26.	12	0			
				12	15
27.	0	15			

These changes may possibly be due to diurnal tide.

The times and intervals of low water are the following:—

	h	m		h	m
February 23.	15	25			
			Interval	12	30
24.	3	55			
				12	5
24.	16	0			
				12	30
25.	4	30			
				13	20
25.	17	50			
				11	25
26.	5	15			
				12	25
26.	17	40			
				12	25
27.	6	5			

These changes are utterly lawless.

The heights of high and low water, (taking for high water, in all cases, the second of the three maxima), and the ranges, are as follows:—

High Water.		Low Water.		Range.	
ft.	in.	ft.	in.	ft.	in.
		4	7⅜		
				12	1⅛
16	8½				
				13	4
		3	4½		
				13	7½
17	0				
				14	0½
		2	11½		
				14	0
16	11½				
				14	10

High Water.		Low Water.		Range.	
ft.	in.	ft.	in.	ft.	in.
		2	1½		
				15	2¼
17	3¾				
				12	9½
		4	6¼		
				13	2¼
17	8½				
				15	9
		1	11½		
				15	6½
17	6				
				15	4
		2	2		
				16	5
18	7				
				16	3
		2	4		

The irregularities here are considerable, and, taken in conjunction with those of the times of low water, they seem to show that some powerful disturbing cause has affected the low water at February 25, 17^h 50^m. Nevertheless, the tidal curves for the tides on both sides of that low water are undistinguishable, as viewed by the eye, from the rest; and in the grouping for the reductions, to be shortly explained, the numbers furnished by them do not differ sensibly from those given by the others.

Considering it then as established that the peculiarities in these tidal curves are the representatives of real peculiarities in the tides at Southampton (such as may always be expected in every individual tide of nearly the same magnitude as those observed on this occasion), and in no degree due to the accidental circumstances of weather; and considering also that these tides exhibit no certain trace of diurnal tide; I shall proceed to explain the method by which they have been reduced into mathematical form.

The method is, in many respects, similar to that which I used for the Deptford tides, in a paper published in the Philosophical Transactions for 1842. The first step was, to divide the whole series of observations into groups, each group representing one tide. This was done by taking the interval from low water to low water as one tide, and supposing it to correspond to 360° of *phase*, and converting the interval between every observation in that tide and its commencement into *phase*, by that proportion. The next step was to reduce the different observations of height to one uniform scale. This was done by assuming every range of tide, from high water to low water or from low water to high water, to be represented by 2, and converting the depression of the water at every observation below the high water of that tide into abstract number, by that proportion. In this manner every observation gave a phase expressed in degrees, and a converted depression expressed in abstract number. The next step was to collect from all the tides the phases between 0° and 5° and their corresponding converted depressions, and to take their mean; then those between 5° and 10°; and so on. The phases thus obtained differed little from 2°·5, 7°·5, &c.; and the correction of converted depression for these small differences being easily found from the preceding and following numbers, the converted depressions for 2°·5, 7°·5, &c. were found. In this manner the following Table was formed:—

Corresponding phases and converted depressions in the Southampton Tides; the phase commencing with low water and increasing by 360° in one tide; and the depression being measured from high water, the whole range being called 2·000.

Phase.	Converted depression.	Phase.	Converted depression.	Phase.	Converted depression.	Phase.	Converted depression.
2°·5	1·996	92°·5	1·194	182°·5	0·064	272°·5	0·217
7·5	1·979	97·5	1·185	187·5	0·029	277·5	0·251
12·5	1·939	102·5	1·182	192·5	0·018	282·5	0·316
17·5	1·890	107·5	1·181	197·5	0·027	287·5	0·384
22·5	1·838	112·5	1·163	202·5	0·051	292·5	0·508
27·5	1·770	117·5	1·128	207·5	0·079	297·5	0·598
32·5	1·698	122·5	1·080	212·5	0·104	302·5	0·755
37·5	1·639	127·5	1·018	217·5	0·132	307·5	0·890
42·5	1·574	132·5	0·941	222·5	0·145	312·5	1·021
47·5	1·519	137·5	0·846	227·5	0·149	317·5	1·201
52·5	1·479	142·5	0·748	232·5	0·152	322·5	1·347
57·5	1·422	147·5	0·651	237·5	0·144	327·5	1·491
62·5	1·382	152·5	0·563	242·5	0·139	332·5	1·641
67·5	1·329	157·5	0·441	247·5	0·125	337·5	1·769
72·5	1·292	162·5	0·350	252·5	0·129	342·5	1·864
77·5	1·256	167·5	0·262	257·5	0·132	347·5	1·932
82·5	1·225	172·5	0·185	262·5	0·143	352·5	1·976
87·5	1·209	177·5	0·119	267·5	0·174	357·5	1·996

By means of these numbers the curve fig. 1 in Plate II. has been constructed.

To express these numbers in a mathematical form by means of a periodic function, it was assumed that the converted depression could be represented by the formula

$$\begin{aligned}&A + B \,.\, \sin \text{phase} + C \,.\, \sin 2 \text{ phase} + D \,.\, \sin 3 \text{ phase} + E \,.\, \sin 4 \text{ phase},\\ &+ b \,.\, \cos \text{phase} + c \,.\, \cos 2 \text{ phase} + d \,.\, \cos 3 \text{ phase} + e \,.\, \cos 4 \text{ phase}.\end{aligned}$$

Then A is the mean of all the converted depressions. B is found by multiplying every converted depression by its value of sin phase, and dividing the sum of all the products by 36. *b* is found in the same way, using the values of cos phase as factors. C is found by using sin 2 phase as factor, &c. In this manner the following expression was found for the converted depression:—

$$\begin{aligned}&0{\cdot}900 + 0{\cdot}469 \,.\, \sin \text{phase} - 0{\cdot}085 \,.\, \sin 2 \text{ phase} - 0{\cdot}057 \,.\, \sin 3 \text{ phase} - 0{\cdot}017 \,.\, \sin 4 \text{ phase}\\ &+ 0{\cdot}766 \,.\, \cos \text{phase} + 0{\cdot}174 \,.\, \cos 2 \text{ phase} + 0{\cdot}182 \,.\, \cos 3 \text{ phase} - 0{\cdot}029 \,.\, \cos 4 \text{ phase};\end{aligned}$$

or

$$\begin{aligned}0{\cdot}900 &+ 0{\cdot}898 \,.\, \sin (\text{phase} + 58^\circ\ 30')\\ &+ 0{\cdot}194 \,.\, \sin (2 \text{ phase} + 116^\circ)\\ &+ 0{\cdot}191 \,.\, \sin (3 \text{ phase} + 107^\circ\ 22')\\ &- 0{\cdot}034 \,.\, \sin (4 \text{ phase} + 59^\circ\ 43').\end{aligned}$$

If we make phase $+ 58^\circ{\cdot}30' = p$, this becomes

$$0{\cdot}900 + 0{\cdot}898 \,.\, \sin p + 0{\cdot}194 \,.\, \sin (2\,p - 1^\circ) + 0{\cdot}191 \,.\, (\sin 3\,p - 68^\circ\, 8') - 0{\cdot}034 \,.\, \sin (4\,p - 174^\circ\, 17').$$

The theory of waves, so far as it has yet gone, fails to explain the form of this expression. It is not reconcileable with that obtained on the supposition that the extent of vertical oscillation bears a sensible proportion to the depth, either when the length of the channel is indefinite, or when the channel is interrupted by a barrier*. The latter supposition is that which would seem to represent most exactly the circumstances of Southampton. It is to be remarked, however, that the investigations which I have cited suppose the section of the channel to be rectangular; a supposition which accords little with the state of the channel of the Southampton water, as shown by the extensive banks of mud discovered at low water there. The investigations also exclude friction.

The following consideration is suggested by the form of the expression at which we have arrived for the converted depression. If the tide were such as we suppose the sea-tide to be (that is, if its depression were expressed by a single sine or cosine), and if (as above) the *phase* were measured from low water, then the converted depression would be expressed by

$$A' + B' \cos \text{phase},$$

$$\text{or}\quad A' + B' \sin (\text{phase} + 90^\circ).$$

From this we might be led to conceive that in all cases the argument of the principal term expressing the depression would be (phase + 90°), the *phase* being a quantity which commences from low water. But we find that it does in this instance depend on (phase + 58° 30′), or on (phase + 90° − 31° 30′), differing from the former by 31° 30′, which corresponds to one hour of time nearly. Now there seems to be no reason (except the convenience of mariners) why cotidal lines and speculations on the progress of the tide should be connected with high water rather than with low water, or any other phase of tide; the only thing with which, in a scientific view, they can properly be connected (as it appears to me), is the epoch of the argument of the principal term in the formula for depression. But, in the instance of Southampton, the time of actual low water differs from the time of greatest depression given by that term, by one hour; the times of high water differ about forty minutes. If then the peculiarity of the Southampton tide has been created in part by the shallowness of the English channel, and exists on the coast (we have no accurate information whether this is true or not), then the position of the cotidal line determined by the high water is erroneous, with reference to the views above mentioned, to a considerable extent.

Another consideration suggested by the same expression is this. The mean of the depressions at high-water and at low-water is 1·000. But the constant term which enters into the general formula for the depression is 0·900. Now I conceive the latter to be the number which truly represents the mean level of the water. In all cases, therefore, in which the mean level of the sea in different places is compared, I conceive it is not sufficient to take the mean of high and low water, but it is necessary to express the depression by the formula $A+B\sin\text{phase}+b\cos\text{phase}+C\sin 2\,\text{phase}+\text{\&c.}$, and to adopt the constant A as determining the mean level. The difference, at Southampton, is about nine inches, by which quantity the *mean level*, as defined above, is higher than the mean of high and low waters.

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* See Philosophical Transactions, 1842, p. 6.

The singularity of the results obtained at Southampton induced me to take measures for observing the tides in another estuary; and for this purpose I selected Ipswich as a good station. The positions of these places are not exactly similar: Southampton is *nearly* at the head of its gulf; Ipswich may be considered as being *absolutely* at the head of its gulf. The length of the Orwell does not differ materially from that of the Southampton water; and in depth, breadth, magnitude of tide, &c., it resembles it closely. Nevertheless, it will appear from the following results that the laws of the tides at these two places are extremely different.

An application made by me to Charles May, Esq. of Ipswich, was by him laid before the Dock Committee; and I received from that body a most courteous offer of every assistance which could be required for the observation of the tides. The immediate superintendence of the observations was undertaken by James Jones, Esq., Dockmaster; and to the talent and spirit with which this gentleman undertook the troublesome business, I am entirely indebted for the opportunity of presenting the Royal Society with trustworthy results.

The observations commenced on 1842, May 24, $23^{h}\ 40^{m}$ (astronomical reckoning), and finished on May 27, $3^{h}\ 35^{m}$; embracing four complete tides. The height of the water was observed at every five minutes. The zero of the scale is the Lock Sill. Great attention was given to the determination of time. No irregularity appears on the face of the observations except about May 25, 19^{h}, after a heavy squall from the S.S.E. with violent rain.

The times and intervals of high water are as follows:—

	h m		h m
May 25. . .	1 5		
		. . Interval .	12 15
25. . .	13 20		
		. . . . . .	12 30
26. . .	1 50		
		. . . . . .	12 10
26. . .	14 0		
		. . . . . .	12 34
27. . .	2 34		

The times and intervals of low water are,—

	h m		h m
May 25. . .	6 55		
		. . Interval . .	11 40
25. . .	18 35		
		. . . .	12 55
26. . .	7 30		
		. . . .	12 15
26 . .	19 45.		

And the heights and ranges are,—

High Water.		Low Water.		Range.	
ft.	in.	ft.	in.	ft.	in.
15	10¼				
				12	0¾
		3	9½		
				12	0½
15	10				
				11	3¼
		4	6¾		
				12	3¾
16	10½				
				11	11½
		4	11		
				12	0½
16	11½				
				11	8
		5	3½		
				11	0¼
16	3¾				

The observations were reduced in exactly the same way as those made at Southampton, with this single difference, that the *phase* here began from high water (the first and last conspicuous phenomenon in these observations having been high water). And the values thus found for the converted depression are the following.

Corresponding phases and converted depressions in the Ipswich tides: the phase commencing with *high* water and increasing by 360° in one tide; and the depression being measured from high water, the whole range being called 2·000.

Phase.	Converted depression.	Phase.	Converted depression.	Phase.	Converted depression.	Phase.	Converted depression.
2°·5	0·012	92°·5	1·197	182°·5	1·894	272°·5	0·984
7·5	0·053	97·5	1·276	187·5	1·869	277·5	0·940
12·5	0·120	102·5	1·362	192·5	1·822	282·5	0·891
17·5	0·184	107·5	1·449	197·5	1·779	287·5	0·841
22·5	0·251	112·5	1·527	202·5	1·723	292·5	0·791
27·5	0·322	117·5	1·599	207·5	1·658	297·5	0·736
32·5	0·389	122·5	1·674	212·5	1·586	302·5	0·668
37·5	0·449	127·5	1·731	217·5	1·516	307·5	0·625
42·5	0·513	132·5	1·780	222·5	1·449	312·5	0·564
47·5	0·570	137·5	1·828	227·5	1·381	317·5	0·497
52·5	0·631	142·5	1·874	232·5	1·315	322·5	0·437
57·5	0·689	147·5	1·910	237·5	1·258	327·5	0·367
62·5	0·757	152·5	1·940	242·5	1·211	332·5	0·297
67·5	0·822	157·5	1·964	247·5	1·179	337·5	0·231
72·5	0·890	162·5	1·978	252·5	1·144	342·5	0·168
77·5	0·961	167·5	1·985	257·5	1·107	347·5	0·100
82·5	1·043	172·5	1·974	262·5	1·068	352·5	0·043
87·5	1·117	177·5	1·941	267·5	1·030	357·5	0·011

By means of these numbers the curve fig. 2 in Plate III. has been constructed. To make the phase commence at low water, its numerical value must be diminished by about 166°.

Treating these numbers in the same way as those for Southampton, and still conceiving the phase to commence at high water, we obtain the following formula for the converted depression :—

$$1{\cdot}055 + 0{\cdot}112 \,.\, \sin \text{phase} - 0{\cdot}096 \,.\, \sin 2\text{phase} + 0{\cdot}030 \,.\, \sin 3\text{phase} + 0{\cdot}012 \,.\, \sin 4\text{phase}$$
$$- 0{\cdot}851 \,.\, \cos \text{phase} - 0{\cdot}041 \,.\, \cos 2\text{phase} - 0{\cdot}076 \,.\, \cos 3\text{phase} - 0{\cdot}023 \,.\, \cos 4\text{phase};$$

or

$$1{\cdot}055 + 0{\cdot}858 \,.\, \sin(\text{phase} - 82^\circ\, 31') - 0{\cdot}104 \,.\, \sin(2\text{phase} + 22^\circ\, 59')$$
$$+ 0{\cdot}082 \,.\, \sin(3\text{phase} - 68^\circ\, 23') + 0{\cdot}025 \,.\, \sin(4\text{phase} - 63^\circ\, 2').$$

Let phase $- 82^\circ\, 31' = p$; this becomes

$$1{\cdot}055 + 0{\cdot}858 \,.\, \sin p + 0{\cdot}104 \,.\, \sin(2p + 8^\circ\, 1') - 0{\cdot}082 \,.\, \sin(3p - 0^\circ\, 50')$$
$$- 0{\cdot}025 \,.\, \sin(4p + 87^\circ\, 2').$$

The first three terms of this expression are extremely similar to those in the expression for the Southampton tide: the principal difference between the two expressions is in the fourth term, or that depending on $3p$. It is very remarkable that the algebraical difference between the formulæ for tides which are so strikingly different in general character, depends entirely on a term of the third order of the fraction expressing the proportion of the vertical oscillation to the depth of the water; an order to which (so far as I am aware) theory has reached only in one instance, namely that of a wave travelling along an unlimited canal, and then only on the restricted suppositions of rectangular section and absence of friction*. It is also worthy of remark, that the terms of the second order do not agree with those given by the restricted theory to which I have alluded, and that they differ materially from those given by the Deptford tides†. From a consideration of the discordance between the observations and the present state of theory in regard to the form of these terms, as well as from remarking the influence which they have upon cotidal lines and mean levels, I am inclined to fix upon the circumstances of waves in canals as more deserving of notice at the present time, both in theory and in observation, than almost any other branch of the theory of tides.

I take this opportunity of correcting an error in my paper on the Deptford tides‡. I have there stated, on the authority of Mr. WHEWELL§, that the age of the tide as inferred from the heights is greater than its age as inferred from the times. This, however, is incorrect. The age inferred from the heights is, in every instance that has been properly examined, less than that inferred from the times‖. I trust that, in a subject which is at first examination very confusing, it will be regarded as a venial fault to have erred in such company as that of Mr. WHEWELL.

In a theoretical view, this correction is very important. The cause assigned for the greater age inferred from the heights* is certain, as it is one given by observations which (here according with theory) show that the rise of tide occupies a shorter time at springs than at neaps. Some other cause must therefore exist, of such a kind as to make the tide later in springs than in neaps, and of such a magnitude as completely to overrule that already assigned. I conceive that this cause may be the increased range of the tide in horizontal extent up the river, at springs; by which the tide is changed from a gulf-tide to a continuous-canal-tide, which travels more slowly. But without more rigorous theory, I dare not pronounce upon this point.

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* See Philosophical Transactions, 1842, p. 6, and Encyclopædia Metropolitana, *Tides and Waves*, Article 210.

† Philosophical Transactions, 1842.

‡ Ibid. p. 8.

§ Ibid. 1838, p. 236.

‖ Encyclopædia Metropolitana, *Tides and Waves*, Article 543.

Royal Observatory, Greenwich,
February 10th, 1843.

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* Philosophical Transactions, 1842, p. 8.

VII. *Tide Observations at Otaheite, or Tahiti.*

By Captain Sir E. Belcher, *R.N. Communicated by Captain* Beaufort, *R.N., F.R.S., &c.*

Received October 31, 1842,—Read February 16, 1843.

H. M. Ship Sulphur, Spithead,
July 22, 1842.

Sir,

WITH reference to that part of my instructions relating to noon high water at the Island of Otaheite, or Tahiti, I now transmit to you fair copies of the tide-journal registered at the island of Motouta, in the harbour of Papiete, as well as a short comparative series made at Point Venus.

The island of Motouta, the position before named, is the property of the Queen, and therefore free from intrusion or likelihood of disturbance. It is situated well within the reefs, upon a coral flat, and any wave tumbling over the reef would expend itself before reaching the island.

It is, at the same time, within the direct influence of the deep water channel, to seaward, but entirely protected by the reef. The swell does not enter by reason of the overlapping tongue of the northern reef, which, projecting westerly, receives and throws off the sea obliquely. The gauge was placed in ten feet of water, and the batten in four.

In order to prevent any confusion, by change of observers, and thus destroying the interest which a single individual would feel if entrusted with the sole execution of this interesting duty, I selected one of my old followers, Mr. McKinley Richardson, Mate, and placing him in entire charge of the island, furnished him with a tide-gauge of my own construction, as well as a tide-batten.

The tide-gauge was constructed as follows (Plate IV.):—A square wooden trunk of six inches aperture, *a a*, was closed at the bottom, but admitted water by small lateral holes, *b b*, six inches from the bottom. This was to prevent any sudden wave which might roll in from affecting the mean level.

Within this trunk floated a glass cylindrical jar *c*, five inches in diameter by eleven in height, and ballasted with sufficient small shot to half immerse it. It was rendered air-tight by means of the gauge-rod which screwed into an interior stuffed pad against the collar of the exterior.

The end of this rod was of brass, where it screwed into the float, but for ten feet above was of very light, tough cypress, half an inch in diameter.

At the summit of the trunk a cap was fitted, *d*, having three friction rollers, through which the rod traversed freely. Above the trunk, secured to strong uprights, stepping into its exterior sides *e*, *e*, the graduated battens rose, having a clear space between them, and very neatly and *strongly* graduated with black divisions on a white ground.

The index had a clamp tube, through which the gauge-rod passed, *f*, when it was finally clamped at the first high water.

The index was a piece of machinery, *per se*, *f f*. It was furnished with fore, as well as back, friction rollers, on springs, amounting to eight, by which it maintained its position steadily, and kept the gauge-rod perpendicular. This machine had been well tested at Bow Island and its imperfections obviated.

This gauge was fixed upon the abrupt steep of the reef in ten feet water, and well ballasted by pigs of iron, on which it also rested. It was distant from the wall thirty yards, and easily read off by a telescope. It was registered during daylight (from 6 A.M. until 6 P.M.) *from the top*, so that the *least* number indicated high water, and *vice versâ*.

The tide-batten was lashed to the rocks (similarly ballasted) close to the wall of Motouta, in four feet water, and a thick plank enabled the observer to take the closest inspection. It was registered from the *bottom* by day as well as night, and by day at the same periods as the tide-gauge. The *greatest* number therefore indicates high water.

As it is almost impossible to determine the actual moment of high or low water, I had recourse to the method of equal altitudes, within two hours on each side; as the results of my observations on the coast of Lancashire, where the water was subject to a rise and fall of thirty-one feet, always coincided up to the latest half hour.

I have been thus minute in order to satisfy any sceptical minds bent on the maintenance of the *absolute noon period*, that the minutest attention was devoted to this duty, and the coincidence of the two observers, five miles asunder, will in some points be found to agree minutely.

It will be seen by reference to the mean tide-levels, subsequently reduced for each day (and *not contemplated* by the observers themselves), how strictly this duty was attended to, the range never exceeding *two inches* on either gauge or batten.

The position at Matavai was at the extremity of Point Venus, which was shielded in a great measure from the influence of the sea, by reefs similar to those at Papiete; but here we had merely tide-battens; the observations, however, were corroborated by repetitions within the rivulet, on a pole with crosses to mark the simultaneous levels, the more readily to deduce the moments of high and low water. These were watched for the last week by Mr. CHRISTOPHER GEORGE, second master, my general assistant in the observatory, and superintendent of the tide-journals.

These data (from the 22nd to the 27th) are comparable with those observed at Motouta.

By these documents it will be observed that there were two irregular moments of high water during each twenty-four hours, and that their range was from 10 A.M. to $2^h\ 27^m$ P.M., or nearly $4^h\ 27^m$ by day, and $3^h\ 20^m$ by night. The influences of the sea or land breezes are not apparent. Indeed, if any such influence be admitted, it is decidedly at variance with the anticipated effect, as the night tides are *higher* with the land wind *off shore*.

With a *strong* land wind the height generally indicated the same as in calm. But the mean tide-levels before alluded to, distinctly indicate *an equable rise and fall*.

The night tides observed at Point Venus do not so exactly accord with those observed at Motouta.

I much regret that we had not an opportunity of observing the whole lunation; but I trust that sufficient has been advanced to satisfy you that no exertion was wanting in carrying through these intricate labours, and that even in their present form they may prove not altogether without interest.

I am Sir,
Your most obedient Servant,
EDWARD BELCHER, Captain.

Captain F. BEAUFORT, *R.N.*,
Hydrographer.

Abstract of Tide Observations.—TABLE I.

Otaheite. Island of Motouta. April 1840.

Date.	Mean time of		Duration of		Height of Tide by		Extreme Rise and Fall.		Mean Tide Level.			Moon's			Diff. of Moon's Passage and High Water.	Weather, &c.
	High Water.	Low Water.	Flood.	Ebb.	Gauge.	Batten.	Gauge.	Batten.	Gauge.	Batten.	Diff.	Age.	Change.	Passage.		
	h m	h m	ft. ins.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	h m	d h m	h m	h m	
☿ 8.	2 27 P.M.	.... 8 36	....	.... 6 9	3 10¼	1 6¾	0 1¾	0 4¾	3 9½	1 9	2 0½	5 9	☽ Q. 8 18 22	P.M. 5 21	2 54	Wind { from 9 0 A.M. to 4 0 P.M. S.W. 3 5 B.C. 4 P.M. 6 0 Calm. 0 B.C. 6 10 0 E.S.E. 3 B.C. 10 Mid. N.N.E. 2 B.C. At 4 P.M. the wind outside the reefs was apparently N.W.
♃ 9.	10 44 A.M. 10 00 P.M.	....	Tide irregular.		3 10¼ 3 4	1 8½ 2 1½	0 6½	0 5	3 7¼	1 11	1 8¼	6 9	....	6 20	3 40	Wind { from 0 0 to 9 0 A.M. N.N.E. 1 3 B.C. 9 0 Mid. S.W. 1 5 B.C.
♀ 10.	A.M. 10 45 .... 10 12	5 38 .... 4 36	.... 5 7 .... 5 36	7 38 .... 6 9	3 5 3 11½	2 2½ 1 7½	0 6½	0 7	3 8¼	1 11¼	1 9	7 9	....	P.M. 7 15	2 57	Wind { from 0 0 to 2 0 Calm 0 B.C. 2 0 8 30 S.E.&E. 2 B.C. 8 30 9 0 S.W. 2 9 0 Mid. S.E. to E. 2 4 B.C.
♄ 11.	A.M. 10 43 P.M. 11 40	6 5 .... 5 35	.... 4 38 .... 6 8	7 53 .... 6 5	4 1½ 3 5	1 5½ 2 4½	0 8½	0 11½	3 8½	1 9½	1 11	8 9	....	8 7	3 33	Wind { from 0 0 to 5 0 A.M. Calm 0 B.C. 5 0 5 P.M. East 1 4 B.C.N. 5 0 Mid. S.E. 2 B.C.
☉ 12.	A.M. 10 0 .... 11 47	5 32 .... 5 25	.... 4 28 .... 6 12	5 52 .... 4 35	4 0 3 3½	2 5½ 1 4	0 8½	1 1½	3 8½	1 9	1 11½	9 9	....	8 54	2 53	Wind { from 0 0 to Noon N.N.E. 1 B.C. 1 Mid. Vble. Vble. 2 B.C.N.
☽ 13.	A.M. 11 20 .... 0 35 P.M.	6 0 .... 5 20	.... 5 42 .... 5 22	6 13 .... 5 26	3 2 4 3½	1 3 2 5½	1 1½	1 2½	3 9	1 10	1 11	10 9	....	9 37	2 58	Wind { from 0 0 A.M. to 9 0 A.M. Calm 0 B.C. 9 0 Mid. N.E. 1 2 B.C. R.P.M.
♂ 14.	.... 11 26 A.M. .... 11 42 P.M.	5 44 .... 6 20	.... 5 42 .... 5 22	5 9 .... 5 26	3 2 4 3½	2 5½ 1 3	1 1½	1 2½	3 9	1 10	1 11	11 9	....	10 22	0 53	Wind { from Easterly all day. 1 2 B.C. B.C.L.
☿ 15.	.... 11 50 A.M. .... 11 48 P.M.	6 2 .... 7 1	.... 5 48 .... 4 47	6 20 .... 4 49	4 3¼ 3 1	1 3 2 7½	1 2¼	1 4½	3 8¼	1 11¼	1 9	12 9	....	11 0	0 48	Wind { Easterly all day. 2 4 B.C. B.C.T.L. R.Q.C. R.O.Q.P.

TABLE I. (Continued.)

Otaheite. Island of Motouta. April 1842.

Date.	Mean time of		Duration of		Height of Tide by		Extreme Rise and Fall.		Mean Tide Level.			Moon's			Diff. of Moon's Passage and High Water.	Weather, &c.
	High Water.	Low Water.	Flood.	Ebb.	Gauge.	Batten.	Gauge.	Batten.	Gauge.	Batten.	Diff.	Age.	Change.	Passage.		
	h m	h m	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	h m	d h m	h m	h m	h m h m
♃ 16.	.... 11 52 A.M.	7 0 .... 6 40	.... 4 52	7 18 .... 5 12	.... 4 3 3 0	.... 2 5 1 02	1 3	1 3	3 7½	1 10	1 9½	13 9	⊙ F. M. 16 7 55			Wind { from 0 0 to 6 0 A.M. Easterly. 1 B. C. 6 0 8 0 Calm. 0 B. C. 8 0 Mid. Easterly. 2 B. C.
♀ 17.	1 10 A.M. .... 0 25 P.M.	.... 6 48 .... 7 35	6 30 .... 5 37	.... 5 38 .... 4 50	4 2 3 3	2 7 1 3½	0 11½	1 3½	3 8½	1 10¾	1 9¾	14 9	....	0 26	0 54	Wind { from 0 0 A.M. to 9 0 A.M. Calm. 0 B. C. 9 1 30 Calm. 0 1 30 3 0 N.W. 2 3 B. C. 3 0 Mid. Calm. 3 B. C.
♄ 18.	1 20 A.M. .... 1 10 P.M.	.... 6 38 .... 7 0	5 45 .... 6 32	.... 5 18 .... 5 50	3 3 4 1½	2 5 1 4½	0 10½	1 0½	3 8¼	1 10¾	1 9¼	15 9	....	1 12	0 8	Wind { from 0 0 A.M. to 6 0 A.M. E.S.E. 1 B. C. 6 0 0 0 Calm. 1 8 0 4 0 East. 3 4 0 Mid. Calm. 0
⊙ 19.	1 18 A.M. .... 1 10 P.M.	.... 6 20 .... 8 54	6 18 .... 6 50	.... 5 2 .... 7 44	4 0 3 4	2 4 1 3½	0 8	1 1½	3 8	1 11¼	1 8¼	16 9	....	1 58	0 40	Wind { from 0 0 to 8 0 P.M. Calm. 0 B. C. 8 0 Mid. Easterly. 1 2 B. C.
☽ 20.	1 35 A.M. .... 0 45 P.M.	.... 6 55 .... 7 17	4 41 .... 5 50	.... 5 20 .... 6 32	4 1½ 3 5	2 3½ 1 3½	0 8½	0 12	3 9½	1 10	1 11½	17 9	....	2 49	....	Wind { from 0 0 to 6 0 A.M. Easterly. 2 B. C. 6 0 10 0 Calm. 0 10 0 5 30 W.S.W. 1 4 B. C. 5 30 7 0 Calm. 0 B. C. 7 0 Mid. Easterly. 1 B. C.
♂ 21.	1 37 A.M. 0 0	....	Tide irregular, flowing and ebbing at intervals of three hours.				0 10	0 6	3 · 9	1 10	1 11	18 9	....	....	3 40	Wind { from 0 0 A.M. to Noon. Easterly. 2 B. C. Noon 5 0 P.M. N.W. 2 3 B. C. 5 0 9 0 Calm. 0 B. C. 9 0 Mid. S.E. 1 3 B. C.
☿ 22.	2 30 A.M. .... 4 20 P.M.	7 41 8 3 9 15	.... 8 13	.... 5 37 .... 4 55	4 0 3 7½	.... 1 10 1 5½	.... 0 4½	0 5 0 4½	3 9½	1 8¼	2 1½	19 9	....	4 32		Wind { from 0 0 A.M. to 6 0 A.M. S.E. 2 B. C. 6 0 9 0 P.M. Calm. 2 B. C. 9 0 Mid. West. 3 B. C. V.

TABLE I. (Continued.)

Otaheite. Island of Motouta. April 1840.

Date.	Mean time of		Duration of		Height of Tide by		Extreme Rise and Fall.		Mean Tide Level.			Moon's			Diff. of Moon's Passage and High Water.	Weather, &c.
	High Water.	Low Water.	Flood.	Ebb.	Gauge.	Battten.	Gauge.	Batten.	Gauge.	Batten.	Diff.	Age.	Change.	Passage.		
	h m	h m	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	h m	d h m	h m	h m	h m h m
♃ 23.	2 30 P.M. ………	……… 7 0	Tide ebbing and flowing at irregular intervals.				0 1¼	0 2½	3 9¾	1 8¾	2 1	20 9	………	5 22	………	Wind from 0 0 A.M. to 5 0 A.M. Easterly. 2 B. C. 5 0 8 0 Calm. 0 B. C. 8 0 4 30 P.M. W.N.W. 1 4 B. C. 4 30 8 0 Calm. 0 B. C. 8 0 Mid. S.E. 5 B. C.
♀ 24.	……… 10 30 A.M. ……… 12 0	4 0 ……… 2 30 ………	……… 6 30 ……… 7 30	9 0 ……… 4 0 ………	3 10¼ 3 9	1 9½ 1 6	0 1½	0 3½	3 9¾	1 10½	1 11¼	21 9	☽ L. Q. 24 11 47	6 12	………	Wind from East to South. Calm and Variable. 1 2 B. C.
♄ 25.	……… 10 15 A.M. ……… 9 15	4 15 ……… 3 30 ………	……… 6 0 ……… 5 45	4 15 ……… 5 15 ………	4 0 3 8	1 11 1 6	0 4	0 5	3 10	1 8½	2 1½	22 9	………	6 59	………	Wind from 0 0 A.M. to 7 30 A.M. S.E. 1 3 B. C. 7 30 9 0 E.N.E. 2 B. C. 9 0 4 0 P.M. N.W. 1 4 B. C. 4 0 Mid. South. 2 5 B. C.
☉ 26.	……… 10 30 A.M. ……… 10 0 P.M.	4 0 ……… 4 15 ………	……… 6 30 ……… 5 45	6 45 ……… 5 45 ………	4 1½ 3 7½	2 0½ 1 4½	0 6	0 8	3 10¼	1 8½	2 2	23 9	………	7 46	………	Wind from Midnight to 10 0 A.M. S.E. 2 B. C. 10 0 4 0 N. by E. 2 B. C. 4 0 Mid. Calm and Variable.
☽ 27.	……… 11 0 A.M. ……… 10 30 P.M.	5 10 ……… 4 0 ………	……… 4 50 ……… 6 30	7 10 ……… 5 0 ………	4 3½ 3 7	2 3 1 3	0 8½	0 12	3 11¼	1 9	2 2½	24 9	………	………	………	Wind from Midnight to 2 0 Calm. 2 0 6 0 S.E. 1 B. C. 6 0 8 0 Calm. 8 0 2 0 N.E. 1 C. 2 0 Mid. Calm.
♂ 28.	……… 11 00 A.M. ……… 9 45 P.M.	5 15 ……… 3 30 ………	……… 5 45 ……… 6 15	6 45 ……… 4 30 ………	4 2 3 6	2 2 1 3½	0 8	0 10½	3 9	1 8¾	2 1½	25 9	………	………	………	Wind from 0 0 to 4 0 E. by N. 3 B. C. 4 0 10 0 S.E. 3 B. C. 10 0 Mid. N. by W. 2 B. C.
☿ 29.	……… 11 0 A.M.	5 15 ………	……… 5 45	7 30 ………	4 1 3 7½	1 5 1 11½	0 5½	0 6½	3 9¼	1 9	2 2¼	26 9	………	………	………	Wind from 0 0 to 4 0 N. by W. 2 B. C. V. 4 0 6 0 S.E. by E. 2 1 6 0 Mid. Calm & Var. B. C.

TABLE I. (Continued.)

Otaheite. Island of Motouta. May 1840.

Date.	Mean time of		Duration of		Height of Tide by		Extreme Rise and Fall.		Mean Tide Level.			Moon's			Diff. of Moon's Passage and High Water.	Weather, &c.
	High Water.	Low Water.	Flood.	Ebb.	Gauge.	Batten.	Gauge.	Batten.	Gauge.	Batten.	Diff.	Age.	Change.	Passage.		
	h m	h m	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	h m	d h m	h m	h m	h m h m
May ♀ 1.	11 30 A.M. ……	…… 6 20	……	6 50	……	2 2 1 2½	……	0 11½	……	1 8¼	……	28·9	1 12 6	……	……	Wind { from 0 0 to 4 0 S.E. 2 B. C. 4 0 8 0 E.N.E. 4 C. C. 8 0 8 0 E.N.E. 4 or 5 8 0 Mid. S.E. 3 B. C.
♄ 2.	0 49 A.M. …… 11 55 ……	…… 6 30 …… 6 52	6 29 …… 5 25 ……	…… 5 41 …… 6 57	……	2 3½ 1 3	……	1 0½	……	1 9¼	……	0·5	……	……	……	Wind { from 0 0 to 4 0 S.E. 3 B. C. 4 0 8 0 E.S.E. 2 B. C. V. 8 0 Noon. S.W. to E. 2 3 B. C. Noon to Midnight. E.S.E. 3 B. C.
⊙ 3.	0 51 A.M. …… 0 24 P.M. ……	…… 6 49 …… 6 57	6 0 …… 5 35 ……	…… 5 58 …… 6 33	……	2 3 1 3	……	1 0	……	1 9	……	1·5	……	……	……	Wind { from Midnight to 8 0 E.S.E. 3 B. C. 8 0 Mid. East. 3 4 6 B. C. V.
☽ 4.	1 11 A.M. …… 1 16 P.M. ……	…… 7 37 …… 7 15	6 14 …… 5 39 ……	…… 6 26 …… 5 59	……	2 3 1 5	……	0 10	……	1 10	……	2·5	……	……	……	Wind from Midnight to Mid., S.E. to East 2, 4, 6 B. C.
♂ 5.	0 45 A.M. …… 0 57 P.M. ……	…… 6 52 …… 8 30	5 30 …… 6 5 ……	…… 6 7 …… 7 33	……	2 2 1 6	……	0 8	……	1 10	……	3·5	……	……	……	Wind from Midnight to Midnight, Easterly 5 B. C.
☿ 6.	2 27 A.M. …… 2 43 P.M. ……	…… 7 57 …… 8 22	5 57 …… 6 46 ……	…… 5 30 …… 5 39	……	2 2 1 6	……	0 8	……	1 10	……	4·5	……	……	……	Wind from Midnight to Mid., E.N.E. to N.E. 0, 1, 2 B. C.
♃ 7.	Tide irregular.		……	……	……	……	……	……	……	……	……	……	……	……	……	Wind { from Midnight to Midnight. Easterly with Calms. 1, 2, 0 B. V.

TABLE II.

Otaheite. Point Venus. April 1840.

Date.	Mean time of		Duration of		Height of Tide by		Extreme Rise and Fall.		Mean Tide Level.			Moon's			Diff. of Moon's Passage and High Water.	Weather, &c.
	High Water.	Low Water.	Flood.	Ebb.	Gauge.	Batten.	Gauge.	Batten.	Gauge.	Batten.	Diff.	Age.	Change.	Passage.		
	h m	h m	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	h m	d h m	h m	h m	
☿ 22.	4 52 P.M.	9 3 .... 9 11	7 49	.... 5 12	....	4 0 3 7	....	0 5	3 9½	....	....	19 9	....	4 32	....	Wind E.S.E. throughout the day. 2 4 B. C.
♃ 23.	.... 6 3 P.M.	7 41 10 33	7 30	....	....	3 11 3 8½	....	0 2½	3 9¾	....	....	20 9	....	5 22	....	Wind from h m 6 0 A.M. to h m 10 38 S.E. 2 B. C. 10 38 0 30 Calm. 2 0 30 1 10 N.N.W. 3 B. C. 1 10 Mid. Calm. B. C.
♀ 24.	.... 10 12 A.M. .... 7 47 P.M.	6 0 .... 2 18	.... 4 12 .... 5 29	.... 4 6	....	3 11¼ 3 8	....	0 3¼	3 10¾	....	....	21 9	☽ L. Q. 24 11 47	6 12	....	Wind S.E. to E.S.E. throughout the day. 4 B. C.
♄ 25.	10 20 A.M. .... 9 50 P.M.	.... 4 54	.... 4 56	6 34	....	4 2 3 7	....	0 7	3 11½	....	....	22 9	....	6 59	....	Wind from 0 0 A.M. to 2 0 P.M. S.E. 1 B. 2 0 6 0 N.W. 3 B. C. 6 0 Mid. E.S.E. B. C.
☉ 26.	.... 10 52 A.M.	7 20 .... 5 4	.... 3 32	.... 5 12	....	4 2 3 7½	....	0 7½	3 10¾	....	....	23 9	....	7 46	....	Wind S.E. throughout the day. 2 B. C.
☽ 27.	10 51 A.M.	.... 4 58	....	.... 6 7	....	4 2½ 3 7½	....	0 7½	3 10¼	....	....	24 9	....	8 32	....	Wind from 0 0 A.M. to 10 0 E.S.E. 3 B. 10 0 11 0 Calm. 3 B. 11 0 Noon. Easterly. 2 Noon. 5 0 Northerly. 2 B. 5 0 Mid. S.E. 2 B.
♂ 28.	11 16 A.M.	.... 4 56	....	5 42	....	4 3½ 3 6	....	0 9½	3 10¾	....	....	25 9	....	....	....	Wind from 0 0 A.M. to 4 0 S.E. 4 B. C. 4 0 10 0 S.E. by S. 2 B. C. 10 0 Mid. N. by W. 2 B. C.
☿ 29.	.... 11 20 A.M. .... 9 36 P.M.	6 10 .... 5 16	.... 5 10 .... 4 20	.... 5 56	....	4 4 3 6	....	0 10	3 11	....	....	26 9	....	....	....	Wind from Midnight to 4 0 N. by W. 2 B. C. 4 0 8 0 S.E. 1 B.C.V. 8 0 Noon. N.E. 4 Noon. Mid. Calm.

Tide Observations.

Otaheite. Motouta Island. April 1840.

Date.	Moon's age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☿ April 8.	5 9	9 15 A.M.	3 10¼	......	S.W.	3	b.c.	
		37	3 10¼	1 6¾				
		10 4	3 10	1 7½	S.W.	3–4	b.c.	
		19	3 10	1 8				
		11 05	3 10	1 8	S.W.	3–5	b.c.	
		20	3 10	1 8½				
		45	3 10	1 8½	S.W.	3–5	b.c.	
		Noon.	3 9½	1 9½				
		0 35 P.M.	3 9½	1 9	S.W.	3–5	b.c.	
		1 05	3 9¼	1 9½				
		40	3 8½	1 10	S.W.	4	b.c.m.	
		2 4	3 8½	1 11½				
		27	3 8½	1 11½	....	.....	....	High Water 2^h 24^m.
		3 00	3 8	1 11	S.W.	4	b.c.m.	
		16	3 8	1 11				
		30	3 8½	1 10		3		
		50	3 8½	1 9½	S.W.	2	b.c.m.	
		4 02	3 8½	1 9½				
		25	3 8½	1 10	Calm.	.....	....	Breeze outside strong N.W.
		45	3 8½	1 10				
		5 5	3 8½	1 10	....	....	b.c.m.	
		25	3 8½	1 10				
		40	3 8½	1 10				
		50	3 9	1 9½				
		59	3 9	1 9½	E.S.E.	1	....	Land breeze.
		6 20	......	1 9		1		
		50	......	1 8½				
		7 20	......	1 8½				
		51	......	1 8				
		8 49	......	1 7½	E.S.E.	3	b.c.	
		9 12	......	1 8				
		37	......	1 8½		3	....	Low Water 8^h 36^m.
		10 00	......	1 8½				
		30	......	1 8½				
		11 00	......	1 8½	N.N.E.	2		
		26	......	1 8				
		55	......	1 9		2		
		0 25 A.M.	......	1 9	N.N.E.			
♃ 9.	......	1 00	......	1 8½	....	3	b.c.	
		20	......	1 9				
		50	......	1 9				
		2 26	......	1 9	....	....	....	Tide irregular.
		3 00	......	1 9				
		35	......	1 8½	....	2		
		4 10	......	1 9				
		35	......	1 9½				
		5 00	......	1 9½				
		32	......	1 9½	....	2		
		5 50	3 10	1 9½	N.N.E.	3	b.c.	
		6 11	10½	8½				
		26	10½	8½				
		44	9	10				
		52	3 10	1 9½	N.E.	2		

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♃ April 9.	......	7 4 A.M.	3 9½	1 9¼				
		10	9½	9				
		24	10	9½	E.N.E.	2		
		42	9½	10				
		8 00	8½	10½				
		20	8	10½	....	1		
		38	8	10½	E.N.E.	1		
		54	7	11½	Calm.			
		9 5	6½	11½				
		20	6½	11½	W.S.W.	2	b.c.	
		35	5½	2 00	S.W.	4		
		10 2	4	0½				
		20	4	1				
		30	4	1½	S.W.	4	b.c.	
		11 00	5	1½				
		15	5	0½	S.W.	4	b.c.	
		32	5	1	S.W.	5	b.c.	
		46	5½	0½	....	......	....	High Water 10^{h} 44^{m}.
		Noon.	5½	1 11½				
		0 46 P.M.	5½	11½	S.W.	4	b.c.	
		44	5	11½				
		1 2	5	11				
		10	5	11				
		34	5½	11½				
		2 00	6	11½				
		28	6	2 0½	S.W.	3	b.c.	
		44	6	0½				
		3 5	6	1 0½	S.W.	2	b.c.	
		20	6	11½				
		40	5	2 1				
		55	4	2				
		4 4	4	0½	....	......	....	Tide irregular.
		17	4	0				
		40	5	1				
		50	5	1				
		5 2	5	2	S.W.	1	b.c.	
		40	5	1½				
		6 00	3 5	2				
		22	......	1				
		7 4	......	0				
		30	......	0				
		8 2	......	1 11½				
		14	......	11				
		40	......	2 0				
		9 5	......	0½	S.W.	2	b.c.	
		25	......	0½				
		10 0	......	0½	....	......	....	High Water 10^{h} 00^{m}.
		29	......	0½				
		52	......	0½				
		11 22	......	0				
		50	......	0				
		0 2 A.M.	......	2 0				
♀ 10.	......	10	......	1 11				
		1 20	......	10½	Calm.	......	b.c.	
		56	......	11	S.E.	2		

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♀ Ap. 10.	......	2 1 A.M.	......	1 11½				
		30	......	11				
		3 0	......	10½				
		27	......	10½				
		4 5	......	10½	S.E.	3		
		19	......	10½				
		35	......	10				
		5 5	......	9½				
		29	......	9	....	....	....	Low Water 5h 38m.
		52	......	9	....	2		
		6 10	......	9½	....	1		
		28	......	9½	....	1		
		44	3 5	10½	E.	2	b.c.	
		7 4	5½	11				
		10	7	11				
		30	7	11½				
		45	7	11½				
		8 5	7½	11½				
		15	7½	2 0½	S.W.	1	b.c.	
		30	7½	0½				
		39	7	0½				
		9 2	6½	0½	Calm.	.....	b.c.	
		25	6	1	N.E.	1	b.c.	
		40	6	0½				
		10 0	6	0½	....	4		
		20	5	1				
		40	5	2½				
		11 0	5	2	....	....	....	High Water 10h 45m.
		20	6	1½				
		32	6	1				
		0 6 P.M.	6½	1 11				
		32	6½	11½				
		52	7	11				
		1 0	8	10				
		15	8½	9½	N.E.	4	b.c.	
		25	9	9				
		1 40	3 9½	1 8½				
		49	10	8½				
		2 0	10	8½	N.E.	4	b.c.	
		18	10	8				
		30	10	8				
		44	10	8½				
		55	10½	8				
		3 2	10½	8½				
		25	10½	8½				
		40	10½	8½				
		59	10	8½				
		4 10	11	8				
		40	11	7½	....	....	....	Low Water 4h 36m.
		54	11½	8½				
		5 8	11½	8				
		22	11	8½	E.	2	b.c.	
		40	10½	9				
		50	10½	9	Calm.			
		6 2	3 10½	9				
		25	......	1 9				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♀ Ap. 10.	......	6 50 P.M.	......	1 10				
		7 20	......	9				
		40	......	10				
		8 2	......	10				
		28	......	11½	S.E.	1	b.c.	
		9 0	......	2 1½				
		30	......	2	Calm.			
		10 3	......	2	....	....	....	High Water 10^h 3^m.
		30	......	2				
		11 1	......	2				
		20	......	1½	E.	1	b.c.	
		32	......	1				
		46	......	0½				
		0 0	......	2 0	Calm.			
♄ 11.	......	0 14 A.M.	......	0½				
		34	......	1				
		52	......	1½				
		1 19	......	1				
		40	......	0½				
		2 4	......	1 11½	....	1		
		22	......	9½	....	1		
		49	......	8¼	....	1		
		3 14	......	7½				
		34	......	6½				
		48	......	6½				
		4 2	......	6½	Calm.			
		18	......	6½				
		35	......	6½	E.			
		5 00	......	1 6				
		25	......	6				
		6 00	......	5½				
		10	4 0	5½	....	....	....	Low Water 6^h 5^m.
		30	3 11½	7				
		50	11	7				
		7 2	10	8				
		14	10	8½				
		40	9	8½				
		50	8	9				
		8 2	8	10	E.	1	b.c.	
		16	8	11½				
		50	7½	2 0½	....	4		
		9 0	6	0				
		20	6	0½				
		37	6	0½				
		50	6	0½				
		10 0	5	1				
		23	5	1				
		42	5	2				
		11 5	5	1½	....	....	....	High Water 10^h 43^m.
		20	6½	1				
		32	6	1				
		40	5½	1½				
		Noon.	6	2 1	E.	3	b.c.	
		0 20 P.M.	6	0½				
		40	3 7	0				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♄ Ap. 11.	......	1 0 P.M.	3 8	1 10½				
		30	10	10½				
		55	10½	9½	....	3	b.c.v.	
		2 55	11	7				
		3 10	4 0	6½				
		4 10	1	5½				
		50	1½	5	....	2	b.c.v.	
		5 30	1½	5				
		55	1½	5	S.E.	2	c.v.	
		6 10	0½	6½	....	....	....	Low Water 5^h 35^m.
		40	......	7				
		7 10	......	8½				
		40	......	10				
		8 15	......	11	....	2	b.c.	
		50	......	2 1				
		9 25	......	1½				
		55	......	2				
		10 25	......	3				
		11 0	......	4				
		40	......	4½				
		0 20 A.M.	......	4	....	2	b.c.	High Water 11^h 40^m.
		1 00	......	2 2				
☉ 12.	......	20	......	0½				
		50	......	1 11				
		2 30	......	10				
		3 10	......	8				
		40	......	6½				
		4 20	......	5½				
		5 10	......	4				
		32	4 0	4	....	....	....	Low Water 5^h 32^m.
		50	4 0	4				
		6 5	4 0	5				
		35	1	5				
		7 00	1	6				
		25	1	6				
		40	4 0	7				
		8 0	3 10	8				
		10	9½	9				
		32	9	10				
		9 0	7	2 0				
		25	6	0½				
		40	6	1				
		10 1	5½	2				
		20	5	1				
		11 0	6	1				
		Noon.	5½	0½	....	....	....	High Water 10^h 00^m.
		0 30 P.M.	5	0½				
		15	5½	0½				
		1 40	6½	1 11½				
		2 20	7½	10½				
		50	8	10				
		3 2	9	10				
		30	4	6				
		5 0	4	5				
		25	3½	4½	....	....	....	Low Water 5^h 25^m.
		50	3 1	6				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
⊙Ap. 12.	......	6 20 P.M.	......	1 6				
		35	......	8				
		7 5	......	9				
		20	......	10				
		8 5	......	11	N.E.	2	b.c.	
		35	......	2 2				
		9 10	......	2½				
		40	......	3				
		10 15	......	4½				
		45	......	5				
		11 9	......	5				
		45	......	5½	Calm.	1	b.c.	High Water 11^h 47^m.
		0 40 A.M.	......	2 5				
☽ 13.	......	1 20	......	3½				
		55	......	1½				
		3 5	......	0½				
		30	......	1 11	Calm.	......	b.c.	
		50	......	10				
		5 0	......	9				
		20	......	8				
		40	4 2	7				
		6 0	2	5	N.E.	2	....	Low Water 6^h 0^m.
		20	1	6				
		40	0	6				
		7 0	0	7				
		16	3 11	8				
		40	11	7½				
		8 1	10½	8	Calm.			
		20	9	9				
		40	8	11				
		9 0	6	2 0				
		20	5	1	N.E.	1	b.c.	
		40	4	1				
		10 1	5	1				
		34	5½	1				
		46	4	2				
		11 4	4	2				
		18	4	2½				
		Noon.	4	2	Calm.	......	b.c.	High Water 11^h 20^m.
		0 26 P.M.	5	2				
		40	5	1½				
		1 0	6	1	N.E.	1	b.c.	
		20	7	1 11				
		2 0	9	8				
		16	10	8	Calm.	......	b.c.	
		30	11	8				
		3 0	11	8				
		10	11½	7	N.E.	2	b.c.	
		30	11½	6½				
		4 0	11½	6				
		25	11	5½				
		30	4 0	5				
		46	2	4				
		5 0	3	3				
		35	3	3	....	1	b.c.	Low Water 5^h 20^m.
		6 0	4	3½				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☽ Ap. 13.	......	35 P.M.	......	1 4½	....	......	R.	
		6 59	......	5				
		7 14	......	5½				
		30	......	6½	....	......	Strong breeze off the land.	
		45	......	7½				
		8 5	......	1 8½				
		30	......	11				
		55	......	11½				
		9 30	......	2 0				
		10 10	......	2				
		25	......	3½				
		55	......	4½				
		11 20	......	5				
		50	......	5				
		0 35 A.M.	......	2 5½	E.	2	b.c.	High Water 0h 35m.
♂ 14.	......	1 10	......	5				
		50	......	5				
		2 20	......	2				
		3 0	......	1 10				
		30	......	8				
		4 10	......	7				
		50	......	6½				
		5 2	......	4	E.	2	b.c.	
		26	......	4				
		6 2	4 2	4	....	......	....	Low Water 5h 44m.
		26	2	4				
		7 20	0	5				
		55	2	6				
		8 20	3 11	8				
		9 0	9	10				
		26	7	2 1				
		40	4	1				
		10 1	4	2	E.	2	b.c.	
		17	3	3				
		40	3	4				
		11 0	2	4				
		12	2	5				
		22	2	5	....	......	....	High Water 11h 26m.
		40	2	5				
		Noon.	2	4				
		0 20 P.M.	2	3				
		40	3	3				
		1 0	3	3	....	1	b.c.	
		20	4	2				
		30	5	1				
		50	6	0				
		2 2	7	1 11½				
		3 2	9	10				
		20	10	8½				
		40	11	7				
		4 1	11¾	6	....	......	b.c.	
		27	4 1	4				
		40	2	4				
		5 0	4 2	1 3½	E.	1	b.c.	
		20	3	3½				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♂ Ap. 14.	......	5 40 P.M.	4 3	1 3½				
		6 0	......	3	....	......	....	Low Water 6^h 20^m.
		40	......	3				
		7 0	......	4	E.	1	b.c.l.	
		20	......	5				
		45	......	6				
		8 10	......	7½	....	1	b.c.	
		20	......	7½				
		40	......	10				
		9 10	......	11½				
		37	......	2 1½	Calm.	......	b.c.l.	
		10 10	......	3½				
		11 0	......	5				
		30	......	5½	E.	2	b.c.	
		0 20 A.M.	......	5½	....	....	....	High Water 11^h 42^m.
		1 40	......	2 4				
☿ 15.	......	2 0	......	3				
		18	......	2				
		3 0	......	2				
		30	......	2				
		4 5	......	1 10½				
		30	......	8				
		5 0	......	4	E.	2	b.c.	
		20	......	4				
		40	......	3				
		6 0	4 2	3				
		30	3¼	3	E.	4	b.c.	
		7 4	2	4	....	....	....	Low Water 6^h 2^m.
		30	1	5				
		8 10	0	6				
		20	3 11	8				
		9 0	8	9				
		14	7½	10				
		38	6	10	E.	4	b.c.	
		10 1	5½	2 0				
		26	5	0				
		40	4	1				
		11 1	3	2½				
		16	2	4				
		40	1	5				
		50	1½	6				
		Noon.	1	5½	....	4	....	High Water 11^h 50^m.
		0 16 P.M.	1	3				
		38	1½	3				
		1 6	2	3				
		35	2½	2½				
		2 0	3 1	2 2	E.	......	b.c.t.l.	
		16	6*	1	....	....	....	* Gauge went down suddenly 5 inches.
		35	7	1 11½				
		3 0	8	10				
		16	9	9				
		32	10	8				
		45	11	7	E.	3	b.c.t.l.	Heavy rain; lightning over Island of Eimeo.
		4 0	4 0	6				
		16	1	5				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☿ Ap. 15.	......	4 40 P.M.	4 1	1 4½				
		5 0	1	4½	....	2	r.q.c.	
		10	1	5				
		26	2	4½				
		6 0	2	4½	W.N.W.	......	l.q.c.p.	Heavy rain.
		20	....	4½				
		40	....	4				
		7 16	....	1 3	....	....	....	Low Water 7^{h} 1^{m}.
		37	....	5				
		40	......	7½				
		8 10	......	10				
		50	....	2 1				
		9 15	....	2½				
		40	....	3½				
		10 15	....	4½				
		48	....	6				
		11 35	....	7½				
		45	....	7½	....	....	....	High Water 11^{h} 48^{m}.
		0 15 A.M.	......	2 7	E.	1	b.c.l.	
♃ 16.	......	40	....	5½				
		1 15	....	4				
		50	....	2½				
		2 25	....	1				
		3 0	....	1 11				
		30	....	10				
		45	....	9½				
		4 0	....	8½				
		55	....	5½				
		6 0	....	3½				
		15	4 3	3½				
		30	3	3½	Calm.			
		7 0	3	3	....	....	....	Low Water 7^{h} 0^{m}.
		25	2	4				
		45	2½	4½				
		8 0	2	5½				
		20	1	6				
		32	0	7				
		46	3 10	9	Calm.			
		9 0	3 9	1 10½				
		20	8	2 0½				
		40	7	1				
		10 0	5	2				
		22	5	2				
		46	3	4				
		11 20	2	5				
		40	2	5				
		Noon.	2	5				
		0 30 P.M.	1½	5	Calm.	....	....	High Water 11^{h} 52^{m}.
		40	2	4				
		1 0	2	4				
		18	1	3				
		40	0	2				
		2 0	2	2½				
		30	4	0				
		3 0	7	1 11				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♃ Ap. 16.	......	3 11 P.M.	3 8	1 10				
		32	9	9				
		4 0	10	9				
		20	9	8	Calm.	......	b.c.	
		40	4 0	6				
		5 10	3 11½	5				
		25	4 1	4				
		39	2	4				
		46	2	4				
		6 0	3	3½				
		9	2	4	Calm.	......	b.c.	
		20	2	3				
		40	......	2	....	....	....	Low Water 6^{h} 40^{m}.
		7 12	......	4				
		35	......	4½				
		8 0	......	6				
		11	3 11½	6	E.	2	b.c.	Land breeze.
		20	......	6½				
		40	......	7	....	1	b.c.	
		9 0	......	7				
		20	......	9				
		44	......	11	E.	1	b.c.	
		10 0	3 7	11				
		20	......	2 0½				
		40	......	2				
		50	......	3				
		11 0	......	4				
		16	......	4				
		30	......	4				
		36	......	5				
		49	......	5	E.	3	b.c.	
		Midnight.	......	6				
		0 10 A.M.	......	2 6½				
♀ 17.	......	30	......	6½				
		1 0	......	7	....	....	....	High Water 1^{h} 10^{m}.
		20	......	6½				
		45	......	5½				
		55	......	4				
		2 15	......	3½				
		45	......	2½				
		3 5	......	1				
		25	......	1 11				
		50	......	9½				
		4 25	......	8½				
		5 5	......	7½				
		30	......	5½				
		6 15	......	4½				
		40	4 2	4½	Calm.	......	b.c.	
		7 00	2	4½	....	....	....	Low Water 6^{h} 48^{m}.
		18	2¼	4½				
		40	2	5				
		8 00	1	6				
		30	0½	6				
		9 00	3 11	7				
		25	10	8				
		40	8	10	W.	1	b.c.	

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♀ Ap. 17.	......	9 47 A.M.	3 8	1 11				
		10 0	7	11½				
		16	7	11½				
		30	6	2 0½	Calm.			
		40	6	0½				
		11 0	5	1	E.	1	b.c.	
		30	3	2				
		40	3	2				
		50	3	3				
		Noon.	3	3	S.W.	1	b.c.	
		0 10 P.M.	3¼	3½				
		22	3½	4				
		40	3	3½	Calm.	......	....	High Water 0h 25m.
		1 0	3	4				
		20	3	3				
		35	3¼	3½	N.W.	2	b.c.	
		45	4	2½				
		50	4	2½	W. by S.	3	b.c.	
		2 0	4	2½				
		10	4	2½	W.	2	b.c.	
		40	5	0½				
		50	6	0				
		3 0	6	0½	W.N.W.	2		
		20	6½	0				
		35	7½	1 11				
		50	3 9	1 10				
		4 0	9	9				
		20	10	8				
		32	11	7				
		46	4 0	7				
		5 2	0	6½	Calm.			
		10	0	6½				
		30	1	5				
		42	1½	5				
		50	2	5½				
		6 0	2	5½				
		30	......	4				
		40	......	4				
		7 0	......	4	E.	2	b.c.	
		15	......	3½				
		31	......	3½				
		42	......	3½	Calm.	......	....	Low Water 7h 35m.
		56	......	3½				
		8 5	4 2¼	4½				
		22	......	4				
		9 0	......	5½	E.S.E.	2	b.c.	
		30	......	8				
		10 0	3 8	10½				
		25	......	11				
		55	......	2 0				
		11 25	......	1½				
		55	......	2½				
		45	......	3				
		Midnight.	......	3½	E.S.E.	3	b.c.	
♄ Ap. 18.	......	0 30 A.M.	......	2 3½				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♃ Ap. 18.	......	1 0 A.M.	......	2 5				
		20	......	5	......	......	......	High Water 1^h 20^m.
		40	......	5				
		2 5	......	4				
		30	......	2½				
		50	......	1½				
		3 20	......	0				
		40	......	1 11				
		4 0	......	10				
		40	......	9				
		5 0	......	8				
		30	......	7				
		6 0	4 0½	6				
		20	0½	6				
		30	1	5½				
		40	1	5½	......	......	......	Low Water 6^h 38^m.
		7 0	1	5½				
		20	1	6				
		40	4 1	1 6				
		8 0	1	6				
		7	1	6				
		45	1	6¼				
		9 5	3 11	7				
		29	10	8				
		40	9½	9				
		10 5	11	10				
		30	8	11				
		50	6	2 0				
		11 0	5	1				
		30	5	1				
		40	4½	1½				
		Noon.	3½	2½				
		0 15 P.M.	3	3				
		30	3	4				
		40	3	4				
		50	3	4				
		1 0	3	5				
		20	2½	4½	Calm.	......	b.c.	
		30	3	4				
		2 5	2½	3½				
		25	2½	3				
		3 2	2½	3				
		30	5	2				
		45	7	0½	S.W.	3	P.R.	
		4 0	9	1 10½				
		20	10½	9				
		5 0	4 0	7½				
		20	1	6				
		6 0	1½	4½				
		20	......	4½				
		40	......	4½				
		7 20	......	4½				
		50	......	4½				
		8 20	......	4½				
		50	......	5				
		9 30	......	6½				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♄ Ap. 18.	......	10 10 P.M.	......	1 8				
		40	......	9½				
		11 10	......	11				
		30	......	2 0				
		Midnight.	......	1½				
		0 40 A.M.	......	2 3	S.	2	b.c.	
⊙ 19.	......	1 5	......	4				
		30	......	4	....	....	....	High Water 1h 18m.
		2 0	......	3				
		40	......	1½				
		3 20	......	2 0½				
		40	......	1 11½				
		4 0	......	11				
		50	......	10				
		5 0	......	9½				
		30	......	9				
		40	......	8				
		6 0	......	7				
		10	......	6				
		20	4 0	3½	....	....	....	Low Water.
		40	1	1 5½				
		7 0	1	5½	Calm.	......	b.c.	
		10	1	5½				
		30	1	5½				
		40	1	5½				
		8 0	1½	5½				
		30	1	7	S.W.	1	b.c.	
		45	0	6½				
		9 5	1	6½	Calm.			
		20	0	7				
		30	0	7				
		45	3 11½	7				
		10 0	11	7	N.E.	2	b.c.	
		20	10½	8				
		40	10	9				
		50	9	10				
		11 0	9	11½	W.N.W.	2–4	b.c.	
		20	7	12½				
		40	6½	2 0½				
		12 0	6	1½	....	4	b.c.	
		0 20 P.M.	5	2				
		30	5½	2½	W.	4	b.c.	
		40	5	2½				
		50	5	2½	Calm.			
		55	4½	2½				
		1 0	4	3	N.W.	3	b.c.	
		15	4	3				
		31	4	2½	....	....	....	High Water 1h 10m.
		40	5	2½	W.	3	b.c.	
		50	4	2				
		2 0	4	2				
		24	4½	1½				
		40	5	1				
		3 0	5	1				
		25	6	2 0	W.	2	b.c.	

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
⊙ Ap. 19.	......	3 30 P.M.	3 6½	1 11½				
		49	7	11				
		4 00	8	10				
		18	9	9½				
		4 43	3 10	1 9	....	1	b.c.	
		5 0	10½	8	E.N.E.	2	b.c.	
		20	11	8				
		35	11½	7				
		52	11½	7				
		6 25	......	6	E.	......	b.c.	
		40	......	5½				
		55	......	5½	E.	1	b.	
		7 10	......	5½				
		35	......	5½				
		50	......	5½				
		8 0	......	5½				
		30	......	5				
		55	......	4	....	......	....	Low Water 8h 54m.
		9 25	......	6				
		10 00	......	6				
		20	......	6½				
		40	......	7				
		50	......	9				
		11 15	......	10½				
		35	......	11	E.	2	b.	
		Midnight.	......	2 0				
		0 30 A.M.	......	2 2				
☽ 20.	......	1 0	......	2½				
		20	......	3				
		30	......	3½				
		2 0	......	2½	....	....	....	High Water 1h 35m.
		30	......	1				
		50	......	0				
		3 50	......	1 9½				
		4 0	......	9	E.	2	b.c.	
		30	......	8				
		40	......	7				
		5 00	......	6				
		30	......	5½				
		6 0	......	5½	....	....	......	Strong land breeze.
		10	4 0	5½				
		20	0½	5½	Calm.			
		30	0½	5½				
		40	1	5½	....	3	b.c	
		50	1	5¼	....	1		
		7 0	1	5¼	....	....	....	Low Water 6h 55m.
		10	1	5½				
		20	1	5½				
		30	1½	5½	Calm.			
		40	1½	6				
		50	0½	6	Calm.			
		8 15	0½	6	....	....	....	Tide irregular.
		44	4 0½	1 5½				
		40	0	5½	Calm.			
		9 0	0	6	Calm.			

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☽ Ap. 20.	......	9 20 A.M.	4 0	1 7				
		31	0	7				
		45	0	7				
		10 0	3 11	7				
		15	11	7½				
		30	11	7½	W. ½ N.	2	b.c.	
		11 0	10	9	W S.W.	3	b.c.	
		15	9	9½	....	3	b.c.	
		30	9	9½	....	3		
		45	8	10½	....	4	b.c.	
		12 0	8	10½	....	4	b.c.	
		30 P.M.	6	2 1				
		45	6	1	....	......	....	High Water. (The high water not well determined; batten and gauge differ.)
		1 0	6	1	....	3	b.c.	
		30	6	0½	W.S.W.	2	b.c.	
		2 0	6	0½	W.	3	b.c.	
		20	5½	1½				
		40	5	1				
		50	6	0½				
		3 0	6	0	....	4	b.c.	
		10	6½	1 11½				
		20	6½	11½				
		30	6½	11				
		40	7	10½	Calm.			
		50	7	10½				
		4 0	7½	10				
		10	8	9½	Calm.			
		20	9	8				
		40	10	8				
		5 0	11	7½	W.	2	b.c.	
		10	11	7½				
		20	10½	7				
		30	10	7	W.	3	b.c.	
		40	00	6	....	0	b.c.	
		6 0	......	6				
		20	......	5½				
		35	......	5	....	0	b.c.	
		45	......	4½				
		55	......	4				
		7 2	......	3½	E.	1	b.c.	
		20	......	3½	....	......	....	Low Water 7h 17m.
		35	......	4				
		45	......	4				
		55	......	4				
		8 5	......	4½				
		15	......	4½				
		8 40	......	1 5½				
		9 20	......	5½				
		40	......	5½				
		10 20	......	6½				
		50	......	7½				
		11 20	......	8				
		50	......	9				
		Midnight.	......	9½				
♂ Ap. 21.	......	0 25 A.M.	......	1 10				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♂ Ap. 21.	......	1 0 A.M.	......	2 0				
		30	......	2	....	....	....	High Water 1h 57m.
		2 0	......	3				
		30	......	2				
		3 0	......	1				
		40	......	1 10				
		4 5	......	9½				
		40	......	9				
		5 0	......	9				
		20	......	9				
		6 0	3 9	8½	Calm.	......	b.c.	
		20	10	8				
		7 0	11½	7				
		30	4 0	7				
		8 0	0	7	E.	2	b.c.	
		25	3 11½	8				
		40	11½	7				
		9 0	4 0	7				
		30	0	7				
		10 0	0	8				
		11 0	0	7	S.E.	3	b.c.	
		30	3 11	8	Calm.			
		Noon.	9	9	....	....	....	High Water, irregular.
		0 30 P.M.	8½	7½				
		1 0	8	7	N.W.	2	b.c.	
		30	7½	6½				
		2 0	7½	6½	Calm.			
		30	6½	5½				
		3 0	6½	5½	W.S.W.	2	b.c.	
		30	6	5				
		4 0	7	6	W.	2	b.c.	
		30	8	7				
		5 0	9	8	W.	2	b.c.	
		30	10	9				
		6 0	11	10				
		30	......	9	....	....	....	Tide irregular, ebbing and flowing at three hours intervals.
		7 0	......	6				
		30	......	5½	Calm.			
		8 0	......	1 6				
		30	......	6½				
		9 0	......	7½	S.E.	1		
		30	......	7				
		10 0	......	7½	....	2		
		30	......	7½				
		11 0	......	8	....	3		
		30	......	8				
		Midnight.	......	8	....	3	b.c.	
		0 30 A.M.	......	1 8¼				
☿ 22.	......	1 0	......	9	S.E.	1–3	b.c.	
		30	......	9½				
		2 0	......	10				
		30	......	10	....	....	....	High Water 2h 30m.
		3 0	......	10				
		30	......	9½				
		4 0	......	9½				

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☿ Ap. 22.	......	4 30 A.M.	......	9½				
		5 0	......	10				
		30	......	9				
		6 0	3 11½	9	S.E.	2	b.c.	
		30	11	7½	Calm.			
		7 0	4 0	7	....	......	b.	
		30	0	6				
		8 0	0	6	....	......	....	Low Water 8h 3m.
		30	0	6	....	......	r.	
		9 0	0	6½	....	......	b.c.	
		30	3 11½	7	N.W.	2		
		10 0	11	7	W.	2		
		30	11	7½	....	2		
		11 0	10½	8	....	2	b.c.	
		30	10	8	....	3		
		Noon.	10	8½	....	4	b.c.	
		0 30 P.M.	10	9	....	4	b.c.	
		1 0	9½	9				
		30	10½	8½				
		2 0	10	8½	....	4	b.c.	
		30	9	9				
		3 0	8½	10	....	4	b.c.	
		30	8	10				
		4 0	8	10	....	3	b.c.v.	
		30	8	10				
		5 0	8	10	....	......	....	High Water 4h 20m.
		30	8	10				
		6 0	7½	9½				
		30	......	9½	W.			
		7 0	......	8				
		30	......	7				
		8 0	......	1 6½	....	3		
		30	......	5½				
		9 0	......	5	....	......	....	Low Water 9h 15m.
		30	......	5½				
		10 0	......	6	....	3		
		30	......	6¼				
		11 0	......	7½				
		30	......	6½				
		Midnight.	......	8	....	3		
		0 30 A.M.	......	1 9				
♃ 23.	......	1 0	......	9½				
		30	......	9½				
		2 0	......	9½				
		30	......	9½	....	......	....	High Water 2h 30m.
		3 0	......	9½				
		30	......	9½				
		4 0	......	9½				
		30	......	9	E.	2	b.c.	
		5 0	......	8				
		30	......	8	....	0	b.c.	
		6 0	3 10½	8				
		30	10½	8				
		7 0	10½	7½	....	......	....	Low Water 7h 0m.
		30	10	8				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♃ Ap. 23.	......	8 0 A.M.	3 10	1 8				Tide ebbing and flowing at irregular intervals.
		30	10	8½	N.W.	1	b.c.	
		9 0	10	8½				
		30	9½	8½				
		10 0	9½	9	W.	2	b.c.	
		30	10	8				
		11 0	10	8				
		30	10	8	N.W.	2	b.c.	
		Noon.	10	8				
		0 30 P.M.	10½	8				
		1 0	10	8½				
		30	9½	8½	N.W.	4	b.c.	
		2 0	9½	8½				
		30	9	9	N.W.	2	b.c.	
		3 0	9	10	....	2	b.c.	
		30	9	9½	N.	3	b.c.	
		4 0	9	10	....	2	b.c.	
		30	9	10½	....	2	b.c.	
		5 0	9	9¾	Calm.			
		30	9	9½	S.E.	1	b.c.	
		6 0	9	9	....	2	b.c.	
		30	......	9				
		7 0	......	9	....	0	b.c.	
		30	......	9				
		8 0	......	1 9				
		30	......	8½				
		9 0	......	8½	S.E.	1	b.c.	
		30	......	8½				
		10 0	......	9				
		30	......	9	....	5	b.c.	
		11 0	......	9½	....	5	b.c.	
		30	......	9				
		Midnight.	......	8				
		0 30 A.M.	......	1 7	S.E.	2	b.c.	
♀ 24.	......	1 0	......	7				
		30	......	6½				
		2 0	......	6½				
		30	......	6				
		4 0	......	6	S.	2	b.c.	Low Water 4h 0m.
		30	......	6				
		5 0	......	6				
		30	......	6½	S.S.E.	2–4	b.c.	
		6 0	3 11	7				
		30	11	7½	S.E.	1	b.c.	
		7 0	10½	8	....	1		
		30	10	9	....	1		
		8 0	9½	9	E.	1	b.c.	
		30	9½	8½	Calm.	......	b.c.	
		9 0	10	8½				
		30	9	9	N.E.	1	b.c.	
		10 0	9	9	Calm.			
		30	9	10	W.N.W.	1	b.c.	High Water 10h 30m.
		11 0	10	9½	W.S.W.	3	b.c.	
		30	10	9	....	3	b.c.	
		Noon.	10	8¾				

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♀ Ap. 24.	......	0 30 P.M.	3 10½	1 8	....	2	b.c.	Tide ebbing and flowing at intervals of two hours.
		1 0	10½	7½	....	......	b.c.	
		30	10½	8	Calm.			
		2 0	10½	7½				
		30	10½	7	Variable.	......	b.	Low Water 2^{h} 30^{m}.
		3 0	11	7½	Calm.			
		30	11	7½				
		4 0	10½	8	E.	1	b.c.	
		30	10	7½				
		5 0	9½	7¾	Calm.	......	b.c.	
		30	9	9				
		6 0	......	8½	S.E.	1	b.c.	
		30	......	8½				
		7 0	......	9				
		30	......	9	S.E.			
		8 0	......	1 9	S.	3	b.c.	
		30	......	8½				
		9 0	......	9	S.E.	2	b.c.	
		30	......	9				
		10 0	......	9	E.S.E.	3	b.	
		30	......	9				
		11 0	......	9	E.	1	b.c.	
		30	......	9¼				
		Midnight.	......	9½	Variable.	1	b.	High Water 0^{h} 0^{m}.
		0 30 A.M.	......	1 9				
♄ 25.	......	1 0	......	9				
		30	......	8				
		2 0	......	7½	S.E.	1	b.c.	
		30	......	7				
		3 0	......	6½				
		30	......	6	S.E.	3	b.c.	
		4 0	......	6				
		30	......	6	....	....	....	Low Water 4^{h} 15^{m}.
		5 0	......	6½	S.E.	3	b.c.	
		30	......	6½				
		6 0	......	7	S.E.	2	b.c.	
		30	3 11	7½				
		7 0	11	8	S.S.E.	1	b.c.	
		30	11	8	....	1	b.c.	
		8 0	11	8	E.N.E.	2	b.c.	
		30	10	9				
		9 0	9½	10	E.	1	b.c.	
		30	9	10	Calm.			
		10 0	9	10½	W.N.W.	1–3	b.c.	
		30	8½	10½	....	....	....	High Water 10^{h} 15^{m}.
		11 0	8	10	N.W	3	b.c.	
		30	8½	9½				
		Noon.	8½	9	N.E.	1	b.c.	
		0 30 P.M.	9	9				
		1 0	9½	8	N.N.E.	4–2	b.c.	
		30	10	8	Calm.			
		2 0	10	7	N.W.	3	b.c.	
		30	4 0	6½				
		3 0	0½	6	N.W.	4	b.c.	
		30	1	6	....	....	....	Low Water 3^{h} 30^{m}.

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♄ Ap. 25.	......	4 0 P.M.	4 0½	1 6	N.W.	4	b.c.	
		30	0	6½				
		5 0	0	7	S.	2		
		30	3 11½	7	....	3		
		6 0	11½	8				
		30	......	9½	S.	2	b.c.	
		7 0	......	10				
		30	......	1 10½				
		8 0	......	11	....	3	b.c.	
		30	......	11				
		9 0	......	11				
		30	......	11	....	3	b.c.	High Water 9h 15m.
		10 0	3 7½	11				
		30	......	11	....	5	b.c.	
		11 0	......	10½				
		30	......	10	....	3		
		Midnight.	......	9	S.S.E.	2	b.c.	
		0 30 A.M.	......	1 8				
⊙ 26.	......	1 0	......	7	S.S.E.	3	b.c.	
		30	......	6				
		2 0	......	5	....	3	b.c.	
		30	......	5				
		3 0	......	4¾				
		30	......	4½				
		4 0	......	4½	S.S.E.	3–4	b.c.	Low Water 4h 0m.
		30	......	4½				
		5 0	......	4½				
		30	......	5				
		6 0	......	5	S.	2	b.c.	
		30	4 0	6				
		7 0	3 11½	7	S.E.	1	b.c.	
		30	10½	8½				
		8 0	9½	9	Calm.			
		30	9	9				
		9 0	8½	9½	Variable.			
		30	8½	10				
		10 0	8	10	N.N.E.	3	b.c.	
		30	7½	10	....	....	....	High Water 10h 30m.
		11 0	7½	10	N.N.E.	4	b.c.	
		30	7¾	10				
		Noon.	8¾	10				
		0 30 P.M.	10	9½				
		1 0	11	8				
		30	11½	6½	N.	4	b.	
		2 0	11½	6¼				
		30	11¾	6	....	5	b.	
		3 0	4 0¼	5				
		30	1½	4	....	5	b.	
		4 0	......	1 4	N.	2	b.c.	Low Water 4h 15m.
		30	......	4				
		5 0	......	4	Variable.			
		30	......	4	S.	1	b.	
		6 0	......	4				
		30	......	4½				
		7 0	......	5½				

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☉ Ap. 26.	......	7 30 P.M.	......	1 8	Calm.	0	b.c.	
		8 0	......	1 9	Variable.			
		30	......	10	S.S.E.	3	b.c.	
		9 0	......	1 11	....	5	b.	
		30	......	1 11½				
		10 0	3 6	2 0	....	3–5	b.	High Water 10ʰ 0ᵐ.
		30	......	1 11½				
		11 0	......	1 11				
		30	......	1 10½				
		Midnight.	......	1 10	S.E.	4	b.	
☽ 27.	......	0 30 A.M.	......	1 9				
		1 0	......	1 8				
		30	......	1 7	E.	2	b.	
		2 0	......	1 7				
		30	......	1 6				
		3 0	......	1 5	E.N.E.	3	b.c.	
		30	......	1 4	....	3		
		4 0	......	1 3½				
		30	......	1 3½				
		5 0	......	1 3				
		30	......	1 3				
		6 0	4 2	1 3½				
		30	4 1	1 4½	S.E.	3	b.	Low Water 5ʰ 10ᵐ.
		7 0	4 1	1 4½				
		30	3 11½	1 6				
		8 0	3 10	1 7½	Variable.	2	b.c.	
		30	3 9	1 8½	Calm.	0	b.	
		9 0	3 8½	1 9				
		30	3 8	1 9½				
		10 0	3 7½	1 10	N.	1	b.c.	
		30	3 7	1 10½				
		11 0	3 7	1 11	....	2	....	High Water 11ʰ 0ᵐ.
		30	3 8	1 10				
		Noon.	3 9½	1 9	N.N.W.	3	b.c.v.	
		0 30	3 10	1 8				
		1 0	3 10½	1 7	N.W. by N.	4	b.c.	
		30	3 11	1 6				
		2 0	4 0	1 5				
		30	4 1	1 4	Calm.	0	b.c.	
		3 0	4 2	1 3½	W.S.W.	1		
		30	4 2½	1 2½				
		4 0	4 3¼	1 2	....	....	....	Low Water 4ʰ 0ᵐ.
		30	4 3½	1 2¼	Calm.	0	b.c.	
		5 0	4 3½	1 3				
		30	4 3	1 3	S.W.	2		
		6 0	4 2	1 4				
		0	4 2	1 4	S.W.	2	b.c.	
		30	......	1 4				
		7 0	......	1 4				
		30	......	1 5				
		8 0	......	1 6½				
		30	......	1 8	S.E.	2–4	b.	
		9 0	......	1 11				
		30	......	2 0½				
		10 0	......	2 2	....	....	....	High Water 10ʰ 30ᵐ.

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☽ Ap. 27.	......	10 30 P.M.	......	2 2	Variable.	1	b.	
		11 0	......	2 2				
		30	......	2 1½	S.	3	b.	
		Midnight.	......	2 1				
	......	0 30 A.M.	......	2 1				
♂ 28.		1 0	......	2 0				
		30	......	1 10				
		2 0	......	1 8				
		30	......	1 6				
		3 0	......	1 5	S.	3	b.c.	
		30	......	1 4				
		4 0	.....	1 3				
		30	......	1 3	S.E.	4		
		5 0	......	1 2½	....	4	....	Low Water 5^h 15^m.
		30	4 2	1 2½	....	3		
		6 0	4 1½	1 3				
		30	4 1½	1 3½				
		7 0	4 0	1 5	E.	2	b.c.	
		30	3 11½	1 5½				
		8 0	3 10	1 7½				
		30	3 9½	1 8½				
		9 0	3 8½	1 9½	W.	3	b.c.	
		30	3 8	1 10				
		10 0	3 7	1 11	N.	1	b.c.	
		30	3 6	2 0	....	....	....	High Water 11^h 00^m.
		11 0	3 6½	2 0½	N.N.E.	3		
		30	3 7	2 0				
		Noon.	3 8	1 11	N.N.W.	5	b.c.	
		0 30 P.M.	3 9½	1 8				
		1 0	3 10	1 7	N.N.E.	2–4	b.c.	
		30	3 10	1 7				
		2 0	4 0	1 6				
		30	4 0½	1 5½	N.W.	4	b.c.	
		3 0	4 1	1 5	....	....	....	Low Water 3^h 30^m.
		30	4 0½	1 5				
		4 0	4 0	1 5	N.W.	4	b.c.	
		30	4 0	1 5½				
		5 0	3 11½	1 6	S.	2–3	b.c.	
		30	3 11½	1 6				
		6 0	3 11	1 7	S.	2	b.c.	
		0	3 11	1 7				
		30	......	1 7				
		7 0	......	1 8				
		30	......	1 8½				
		8 0	......	1 9	S.	2	b.c.	
		30	......	1 9½				
		9 0	......	1 11				
		30	......	1 11	....	3	b.c.	
		10 0	3 7½	1 11				
		30	......	1 11				
		11 0	......	1 10½	....	5	b.c.	
		30	......	1 10				
		Midnight.	......	1 9	....	3	b.c.	
☿ 29.	......	0 30 A.M.	......	1 9	S.S.E.	2	b.c.	

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
☿ Ap. 29.	......	1 0 A.M.	......	1 8				
		30	......	1 7				
		2 0	......	1 6	S.S.E.	3	b.	
		30	......	1 6				
		3 0	......	1 5¾				
		30	......	1 5½				
		4 0	......	1 5½	S.S.E.	3–4	b.	
		30	......	1 5				
		5 0	......	1 5				
		30	......	1 5				
		6 0	4 1	1 5	S.	2	b.c.	
		30	4 0	1 6	S.E.	1	b.c.	
		7 0	3 11½	1 7				
		30	3 10½	1 8				
		8 0	3 9½	1 9	Calm.			
		30	3 9	1 10				
		9 0	3 8½	1 10½	N. by E.	2	b.c.	
		30	3 8	1 11				
		10 0	3 8	1 11				
		30	3 7½	1 11				
		11 0	3 7½	1 11¼	N.N.E.	4	b.c.	
		30	3 8	1 11				
		Noon.	3 8¾	1 10½				
♀ May 1.	......	8 20 A.M.	......	1 8	Calm.	0	b.	
		8 37	......	1 9				
		8 55	......	1 10				
		9 25	......	1 11	N.W.	2	b.c.	
		10 00	......	2 0				
		35	......	2 1	....	3		
		11 20	......	2 2	W.N.W.	4		
		40	......	2 2	....	5		
		0 25 P.M.	......	2 1				
		1 10	......	2 0	W.	....	....	High Water 11^{h} 30^{m}.
		30	......	1 11				
		50	......	1 10	W.	5	b.c.	
		2 15	......	1 9				
		45	......	1 8				
		3 30	......	1 7				
		50	......	1 6	W.N.W.	3		
		4 10	......	1 5	N.W.	2		
		15	......	......	N.	2		
		55	......	1 4	N.N.E.	2	b.	
		5 20	......	1 3½	E.N.E.	.....	b.c.	
		50	......	1 3	E.S.E.	1	c.	
		6 25	......	1 2½	S.E.	2		
		45	......	1 2½	....	....	....	Low Water 6^{h} 20^{m}.
		7 0	......	1 3				
		27	......	1 4	S.E. by S.	3–5	b.c.	
		50	......	1 5				
		8 15	......	1 6	....	......	b.	
		40	......	1 7				
		9 0	......	1 8				
		25	......	1 9				
		45	......	1 10				
		10 15	......	1 11	....	2	b.	

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♀ May 1.	......	10 35 P.M.	......	2 0				
		11 0	......	2 1				
		30	......	2 2				
		50	......	2 3	....	1–2	b.	
		0 15 A.M.	......	2 3½				
♄ May 2.	......	1 0	......	2 3½	S.E.	1	b.	
		20	......	2 3½	....	....	....	High Water 0^{h} 49^{m}.
		35	......	2 3				
		50	......	2 2				
		2 05	......	2 1				
		20	......	2 0				
		45	......	1 11				
		3 15	......	1 10				
		35	......	1 9	S.E.	2	b.	
		50	......	1 8				
		4 20	2 3½	1 7				
		40	2 3½	1 6				
		5 5	3	1 5	S.E.	2–3	b.	
		30	2 2	1 4				
		6 5	2 1	1 3				
		40	2 0	1 3	....	....	....	Low Water 6^{h} 30^{m}.
		7 40	1 11	1 4				
		8 0	1 10	1 5	....	2		
		20	1 9	1 6	....	1		
		40	1 8	1 7	Calm.			
		9 5	1 7	1 8				
		25	1 6	1 9	W.	1	b.	
		45	1 5	1 10				
		10 3	1 4	1 11	....	2		
		32	1 3	2 0	....	4		
		55	......	2 1	....	3	b.	
		11 10	......	2 2				
		30	......	2 3				
		Noon.	......	2 4	N.	4	b.	
		12 25 P.M.	......	2 3	....	....	....	High Water 11^{h} 55^{m}.
		40	......	2 2				
		1 0	......	2 1				
		2 0	......	2 0	N.N.E.	5	b.c.	
		20	......	1 11				
		40	......	1 10				
		3 30	......	1 9				
		4 0	......	1 8	N.E.	5		
		20	......	1 7				
		40	......	1 5	S.W.	4	o.c.g.	
		5 20	......	1 4	E.	3	b.c.	
		6 25	......	1 3½				
		7 0	......	1 3	N.E.	1	....	Low Water 6^{h} 52^{m}.
		30	......	1 3				
		8 0	......	1 4	S.E.	1		
		30	......	1 5				
		9 0	......	1 6	....	5	b.	
		20	......	1 7				
		32	......	1 8				
		45	......	1 9				
		10 39	......	1 11				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m	ft. in.	ft. in.				
♄ May 2.	......	11 6 P.M.	......	2 0	E.	1	b.c.	
		34	......	2 1	E.N.E.	1	b.c.	
		0 2 A.M.	......	2 2				
⊙ 3.	......	30	......	2 3				
		1 10	......	2 3	....	....	....	High Water 0h 51m.
		40	......	2 2				
		2 10	......	2 1				
		35	......	2 0				
		35	......	2 0				
		3 5	......	1 11				
		30	......	1 10	S.E.	2	b.	
		4 0	......	1 9				
		25	......	1 8				
		5 0	......	1 7				
		20	......	1 6	....	1	b.	
		50	......	1 5				
		6 30	......	1 4	....	....	....	Low Water 6h 49m.
		7 10	......	1 4				
		50	......	1 5	Calm.	0	b.	
		8 15	......	1 6				
		35	......	1 7	....	0		
		9 10	......	1 8				
		40	......	1 9	W.	1	b.c.	
		10 5	......	1 10	W.S.W.	4		
		25	......	1 11				
		45	......	2 0				
		11 7	......	2 1				
		30	......	2 2				
		Noon.	......	2 2½	....	....	....	High Water 0h 24m.
		1 0 P.M.	......	2 2				
		2 0	......	2 1	S.	5	o.c.g.	
		25	......	2 0				
		55	......	1 11				
		3 20	......	1 10	....	2		
		50	......	1 9	....	5	o.c.	
		4 5	......	1 8				
		25	......	1 7				
		5 9	......	1 6				
		40	......	1 5				
		6 0	......	1 4	....	....	....	Low Water 6h 57m.
		40	......	1 3	S.	3	c.	
		7 10	......	1 3				
		50	......	1 4	....	2	c.	
		8 30	......	1 5				
		9 10	......	1 6	....	2	b.	
		35	......	1 7				
		10 5	......	1 8		1	b.	
		25	......	1 9	....	3		
		50	......	1 10				
		11 15	......	1 11	....	0		
		35	......	2 0				
		Midnight.	......	2 1	....	2	b.	
☽ 4.	......	0 25 A.M.	......	2 2				
		55	......	2 3				

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m		ft. in.				
☽ May 4.	......	1 30 A.M.	......	2 3	Calm.	0	b.c.	
		55	......	2 2	....	......	....	High Water 1^h 11^m.
		2 20	......	2 1				
		35	......	2 0				
		50	......	1 11	S.S.E.	1	b.	
		3 25	......	1 10	....	2–3	b.	
		50	......	1 9				
		4 15	......	1 8				
		40	......	1 7				
		5 10	......	1 6	S.	5	b.	
		6 0	......	1 6	....	3	b.	
		35	......	1 5				
		7 15	......	1 5	Calm.	......	b.	
		8 0	......	1 4½	Calm.			
		45	......	1 5				
		9 10	......	1 6	W.	1	b.	
		50	......	1 7	....	......	....	Low Water 7^h 37^m.
		10 10	......	1 8	W.S.W.	4	b.c.	
		25	......	1 9	....	5		
		38	......	1 10				
		49	......	1 11				
		11 00	......	2 00				
		50	......	2 1				
		0 25 P.M.	......	2 2				
		1 20	......	2 2	....	......	....	High Water 1^h 16^m.
		2 40	......	2 2	N.	6	b.c.	
		3 25	......	2 0				
		4 0	......	1 11				
		15	......	1 10				
		30	......	1 9				
		45	......	1 8				
		5 5	......	1 7	Calm.			
		40	......	1 6	S.S.W.	1	b.c.	
		6 10	......	1 5	....	......	....	Low Water 7^h 15^m.
		40	......	1 5	S.E.	1	b.	
		7 20	......	1 5				
		8 0	......	1 5				
		9 40	......	1 6				
		10 10	......	1 7	....	3	b.	
		30	......	1 8				
		40	......	1 9				
		50	......	1 10				
		11 5	......	1 11				
		20	......	2 0				
		55	......	2 1				
♂ 5.	......	0 40 A.M.	......	2 2				
		1 45	......	2 1	S.S.E.	1	b.	
		2 30	......	2 0	S.E.	3		
		3 20	......	1 11	....	......	....	High Water 0^h 45^m.
		55	......	1 10				
		4 25	......	1 9	Calm.	0	b.	
		50	......	1 8				
		5 30	......	1 7				
		6 20	......	1 6	S.E.	1	b.	
		50	......	1 6				

Table. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m		ft. in.				
♂ May 5.	......	7 25 P.M.	......	1 6				
		55	......	1 7	Calm.	0	b.	Low Water 6^h 32^m.
		8 15	......	1 7				
		40	......	1 7	W.	1	b.	
		9 50	......	1 8				
		10 40	......	1 9				
		11 20	......	1 10	E.	4	b.c.	
		40	......	1 11	Variable.			
		Noon	......	2 0	W.	4	b.c.	
		0 5 P.M.	......	2 2	W.S.W.	4–5	b.c.	
		40	......	2 2	....	......	....	High Water 0^h 57^m.
		1 5	......	2 2				
		30	......	2 2				
		2 35	......	2 1				
		3 10	......	2 0	Variable.	3	b.c.	
		30	......	1 11				
		4 10	......	1 10				
		5 10	......	1 9	N.	3	b.c.	
		6 5	......	1 8	E.N.E.	5	b.	
		40	......	1 7				
		7 0	......	1 7				
		25	......	1 6½	E.	3	b.	
		8 00	......	1 6				
		30	......	1 6	Calm.	0	b.	Low Water 8^h 30^m.
		9 0	......	1 6				
		35	......	1 6				
		10 10	......	1 7				
		50	......	1 8				
		11 30	......	1 9				
☿ 6.	......	0 10 A.M.	......	1 10	E.	2	b.	
		50	......	1 11				
		1 35	......	1 11	....	......	....	High Water 2^h 27^m.
		2 5	......	2 0	Calm.	0	b.	
		40	......	2 0	E.	3	b.	
		3 30	......	1 11				
		4 10	......	1 10				
		50	......	1 9	S.E.	3	b.	
		5 30	......	1 8				
		6 10	......	1 7				
		55	......	1 6				
		7 25	......	1 7	....	......	....	Low Water 7^h 57^m.
		8 20	......	1 7				
		9 10	......	1 7	W.	3	b.c.	
		50	......	1 7				
		10 30	......	1 8	....	5		
		11 0	......	1 9				
		30	......	1 10				
		0 40 P.M.	......	1 11	W.	5	b.c.	
		1 40	......	2 0½				
		2 40	......	2 0½	N.	4	b.c.	
		50	......	2 0	....	......	....	High Water 2^h 43^m.
		3 20	......	2 0				
		40	......	2 0				
		4 40	......	1 11	Calm.	0	b.c.	
		5 10	......	1 10				

TABLE. (Continued.)

Date.	Moon's Age.	Mean Time.	Tide-gauge.	Tide-batten.	Wind.		Weather.	Remarks.
					Direction.	Force.		
	h m	h m		ft. in.				
☿ May 6.	......	5 50 P.M.	......	1 9				
		6 30	......	1 8	E.	1	b.c.	
		7 30	......	1 7				
		8 0	......	1 6½				
		9 0	......	1 7	......	......	......	Low Water 8^h 22^m.
		10	......	1 7				
		10 0	......	1 8				
		11 0	......	1 9				
♃ 7.	......	3 40 A.M.	......	1 6				
		5 40	......	1 7	E.	1	b.	
		6 10	......	1 8				
		50	......	1 9	......	......	......	High Water 9^h 25^m.
		7 15	......	1 8				
		40	......	1 7	S.E.	0	b.	
		8 20	......	1 7				
		9 0	......	1 7	......	......	......	Tide irregular.
		50	......	1 7	N.W.	2	b.c.	
		10 30	......	1 7	W.	3		
		11 20	......	1 7				
		0 20 P.M.	......	1 8				
		0 50	......	1 9	N.W.	4		
		2 55	......	1 10				
		3 55	......	1 10	N.E.	3	b.c.	
		5 40	......	1 11				
		6 25	......	1 11	......	......	......	High Water 6^h 25^m.
		7 10	......	1 10	......	......	......	Low Water 11^h 17^m.
8.		3 15	......	1 10	......	......	......	High Water 3^h 18^m.

METEOROLOGICAL JOURNAL,

KEPT BY THE ASSISTANT SECRETARY,

AT THE APARTMENTS OF THE

ROYAL SOCIETY,

BY ORDER OF

THE PRESIDENT AND COUNCIL.

OBSERVANDA.

Height of the Cistern of the Barometer above the plinth at Waterloo Bridge....83 feet 2 inches.

——————— above the mean level of the sea ....97 feet.

Height of the receiver of the Rain Gauge above the court of Somerset House ..79 feet.

The External Thermometer is 2 feet higher than the Barometer Cistern.

The Thermometers are graduated to Fahrenheit's scale.

The Barometer is divided into inches and tenths.

The Hours of Observation are of Mean Time, the day beginning at Midnight.

The *daily* observations of the Barometer are *not* corrected.

The *monthly means* are corrected for capillarity and temperature by the Table contained in Mr. Baily's paper in *Phil. Trans.* for 1837.

METEOROLOGICAL JOURNAL FOR JULY AND AUGUST, 1842.

1842.	9 o'clock, A.M.			3 o'clock, P.M.			Dew Point at 9 A.M., deg. Fahr.	Diff. of Wet and Dry Bulb Thermometer.	External Thermometers.				Rain in Inches. Read off at 9 A.M.	Direction of the Wind at 9 A.M.	REMARKS.
	Barometer uncorrected.		Att. Ther.	Barometer uncorrected.		Att. Ther.			Fahrenheit.		Self-registering				
	Flint Glass.	Crown Glass.		Flint Glass.	Crown Glass.				9 A.M.	3 P.M.	Lowest	Highest			
JULY															
F 1	29.814	29.806	64.0	29.904	29.896	66.4	57	02.6	51.3	65.2	52.3	70.0	.111	W	A.M. Overcast—light rain and wind. P.M. Cloudy—light wind. Evening, Overcast—light rain.
S 2	29.914	29.908	81.2	29.894	29.886	68.3	55	08.3	63.0	65.7	52.2	76.6	.316	W	Cloudy—light breeze, with occasional showers throughout the day. Evening, Starlight—light clouds.
☉ 3	30.034	30.026	79.0	30.010	30.002	69.0	57	08.3	62.8	69.3	52.0	77.6	.213	W	Cloudy—lt. breeze throughout the day. Ev. Overcast—slight rain.
M 4	29.806	29.800	65.3	29.758	29.750	69.0	60	06.6	64.7	71.7	58.8	71.4	.100	S	A.M. Overcast—light breeze. P.M. Cloudy. Evening, Fine and starlight—light clouds. Rain in the night.
T 5	29.746	29.740	82.8	29.796	29.792	69.4	59	10.0	66.7	68.5	61.4	75.7	.055	SSE var.	Cloudy—very high wind, with occasional showers throughout the day. Rainbow at ½ p. 6. Evening, Overcast—rain.
W 6	30.136	30.130	83.4	30.184	30.178	69.0	52	09.3	62.3	67.2	52.4	79.4	.033	W	A.M. Fine—lt. clouds & breeze. P.M. Cloudy—lt. breeze. Ev. Fine and starlight.
T 7	30.150	30.142	67.2	30.032	30.024	65.8	55	08.2	63.2	59.0	52.3	72.7	.022	SSE	A.M. Cloudy—stiff breeze—rain in the night. P.M. Overcast—light rain & breeze. Ev. The same.
○ F 8	29.856	29.848	70.4	29.776	29.768	66.4	56	06.7	61.8	64.3	54.0	66.6	.041	S	A.M. Fine—light clouds and breeze. P.M. Cloudy—high wind. Evening, Cloudy—light showers.
S 9	29.748	29.742	73.3	29.790	29.782	66.0	58	07.7	62.8	62.4	54.3	73.3	.102	W	A.M. Cloudy—light breeze. P.M. Overcast—light rain and wind. Evening, Cloudy—light rain.
☉ 10	29.970	29.962	80.8	29.950	29.946	68.0	57	08.0	62.2	69.0	53.2	77.8	.116	S	Fine—light clouds and breeze throughout the day. Ev. Cloudy.
M 11	29.724	29.718	68.0	29.650	29.644	68.9	61	07.0	67.2	73.4	56.3	82.7	.072	S	Cloudy—high wind throughout the day. (Rain—high wind during the night.) Evening, Cloudy—light rain.
T 12	29.922	29.914	76.0	30.020	30.012	70.0	59	08.0	65.0	71.5	58.0	75.2	.038	WNW	A.M. Cloudy—lt. breeze. P.M. Fine—lt. clds. Ev. Fine & starlight.
W 13	30.212	30.204	69.7	30.242	30.234	70.4	60	07.8	66.5	70.8	57.3	76.2		SW var.	A.M. Cloudy—stiff breeze. P.M. Dark heavy clouds—stiff breeze. Evening, Fine and starlight.
T 14	30.432	30.424	83.6	30.402	30.394	70.6	60	07.0	63.2	70.3	55.0	76.3		W	Fine—light clouds and breeze throughout the day. Evening, Fine and starlight.
F 15	30.468	30.462	81.0	30.356	30.348	69.8	54	09.8	64.3	71.7	56.0	76.3		N	A.M. Fine—light clouds and breeze. P.M. Fine & cloudless. Evening, Fine and starlight.
S 16	30.250	30.246	84.0	30.150	30.142	69.4	59	07.5	62.8	65.8	54.6	73.2		E	Fine—lt. clouds & breeze throughout the day. Ev. Fine & moonlight.
☉ 17	29.978	29.972	84.5	29.890	29.886	70.0	63	07.2	64.0	65.8	57.3	74.6		E	Fine—light clouds—stiff breeze throughout the day. Ev. Overcast.
M 18	29.886	29.882	70.2	29.894	29.888	70.4	62	06.7	67.2	75.8	59.7	75.6	.036	NW	A.M. Cloudy—lt. fog and breeze. Rain in the night. P.M. Cloudy. Evening, The same.
T 19	29.888	29.880	68.4	29.842	29.836	70.4	61	05.9	64.3	68.8	62.0	77.8		E	Cloudy—light breeze throughout the day—shower early. Evening, Dark heavy clouds—light rain.
W 20	29.790	29.784	76.2	29.768	29.762	69.0	60	07.3	64.7	63.0	57.3	71.0	.033	S	A.M. Fine—light clouds and breeze. P.M. Cloudy—light showers. Ev. Moonlight, with lightning.
T 21	29.772	29.766	67.3	29.834	29.826	66.5	61	05.9	60.8	60.4	56.8	72.4	.038	W	A.M. Ovct.—lt. rain & breeze. P.M. Cloudy, with occasionally slight rain. Ev. Fine & moonlight.
● F 22	30.046	30.040	78.8	30.108	30.100	66.7	54	08.0	59.8	61.7	52.6	72.2	.025	NW	Cloudy—light breeze throughout the day. Evening, The same.
S 23	30.262	30.256	67.3	30.246	30.238	65.6	52	06.7	58.4	64.5	55.0	64.4		NNW	A.M. Cloudy—light breeze. P.M. Fine—light clouds and breeze. Evening, Fine and moonlight, slight fog.
☉ 24	30.180	30.174	76.2	30.076	30.070	67.2	58	07.2	64.3	73.5	53.7	79.7		NNW	A.M. Thick haze—light breeze. P.M. Cloudy—light breeze. Ev. Fine and moonlight.
M 25	29.966	29.958	65.0	29.954	29.946	69.0	63	05.2	64.7	68.2	57.6	76.7		E	A.M. Cloudy—light breeze. P.M. Fine—light clouds and breeze. Evening, Fine and moonlight.
T 26	30.046	30.040	79.8	30.062	30.054	68.8	58	06.7	61.7	69.3	52.4	72.3		N	Fine—lt. clouds & breeze throughout the day. Ev. Fine & starlight.
W 27	30.212	30.204	63.6	30.200	30.192	66.7	58	05.2	57.4	68.7	56.8	71.4	.050	E	A.M. Ovct.—lt. rain. P.M. Fine—lt. clds. & breeze. Ev. Ovct.—slt. rain. ½ p. 12, very hvy. thunder & vivid lightning, until ½ to 6.
T 28	30.112	30.104	70.0	30.020	30.012	67.4	60	02.8	61.3	69.8	56.3	70.3	.091	W	A.M. Overcast—thunder and lightning until ½ p. 6. At ½ to 6, very heavy rain. P.M. Fine—lt. clouds. Ev. Moonlight—lt. clouds.
F 29	29.910	29.902	64.8	29.942	29.936	66.3	53	01.7	53.0	61.2	55.2	71.6	.205	N	A.M. Overcast—light rain and wind. P.M. Fine—light clouds—stiff breeze. Evening, Fine and starlight.
S 30	30.082	30.074	63.2	30.096	30.090	64.3	52	07.2	57.3	62.7	50.4	64.4	.150	NW	Cloudy—lt. breeze throughout the day. Ev. Fine & starlight—lt. clds.
☉ 31	30.186	30.178	61.8	30.206	30.198	64.4	53	05.7	57.8	64.8	55.7	64.5		NW	A.M. Ovct.—lt. wind. P.M. Cloudy—lt. breeze. Ev. Fine & starlt.
MEAN.	30,016	30.009	73.1	30.002	29.995	68.1	58	06.8	62.1	67.2	55.5	73.5	Sum. 1.847		Mean Barometer corrected .... 9 A.M. 3 P.M. F. 29.901 .. 29.900 C. 29.893 .. 29.893
AUGUST															
M 1	30.340	30.334	62.5	30.310	30.302	64.0	53	03.5	58.0	67.3	55.5	67.0		N	Overcast—light wind throughout the day. Evening, The same.
T 2	30.230	30.226	62.0	30.112	30.108	64.5	54	05.0	60.0	70.6	55.0	69.0	.186	SSE	A.M. Overcast—light wind. P.M. Fine—light clouds—brisk wind. Evening, The same.
W 3	30.004	30.000	65.0	29.950	29.944	68.0	62	02.5	64.2	77.4	58.5	71.5	.027	N	A.M. Overcast—light wind. P.M. Fine—light clouds and wind. Evening, The same.
T 4	29.916	29.912	73.0	29.884	29.878	70.5	60	06.5	70.0	80.0	61.0	78.5		N	A.M. Fine—light clouds and wind. P.M. Lightly overcast—brisk wind. Ev. Fine—lt. clouds & wind.
F 5	29.998	29.994	70.0	29.982	29.976	71.0	63	06.5	69.4	73.8	64.5	81.5		S	A.M. Overcast—brisk wind. P.M. Fine—light clouds—brisk wind. Ev. The same.
S 6	29.968	29.964	69.0	29.974	29.970	70.0	64	05.5	68.2	68.6	63.2	75.5		S	A.M. Overcast—light rain & wind. P.M. Slightly overcast—light wind. Evening, Overcast—light rain.
○☉ 7	30.040	30.036	71.2	30.000	29.996	70.4	56	07.0	65.0	73.0	60.0	70.5	.172	SE var.	Fine—light clouds and wind throughout the day. Ev. The same.
M 8	30.110	30.104	72.0	30.090	30.084	71.0	60	06.9	68.0	74.5	58.0	74.5		S	A.M. Lightly overcast—light wind. P.M. Fine—light clouds and wind. Evening, Fine and starlight.
T 9	30.092	30.086	74.0	30.004	30.000	72.0	59	08.4	69.8	77.0	60.2	80.0		ESE	Fine—nearly cloudless—brisk wind throughout the day. Ev. Fine & starlight.
W 10	29.794	29.790	74.0	29.660	29.656	75.0	63	12.5	80.0	83.6	66.0	82.5		SE	A.M. Fine—light clouds and wind. P.M. Overcast—brisk wind. Ev. Overcast—heavy rain, with thunder and lightning.
T 11	29.936	29.932	76.0	30.090	30.084	72.0	57	08.2	65.0	69.9	62.0	87.0	.250	E var.	Fine—light clouds, with brisk wind throughout the day. Evening, Fine and starlight.
F 12	30.350	30.346	74.0	30.334	30.328	72.0	58	06.8	66.4	73.0	59.5	76.0	.138	SSE	A.M. Fine—light clouds—brisk wind. P.M. Fine and cloudless—brisk wind. Evening, Fine and starlight—brisk wind.
S 13	30.468	30.462	69.0	30.472	30.466	71.2	64	03.5	67.5	73.5	61.2	76.0	.172	S	Overcast—light wind throughout the day. Ev. Fine and starlight.
☉ 14	30.472	30.466	72.0	30.396	30.392	73.0	65	06.0	72.0	79.6	65.2	75.2	.083	W	A.M. Light fog. P.M. Fine—light clouds and wind. Evening, Fine and starlight—light wind.
M 15	30.288	30.282	73.0	30.210	30.204	74.0	65	05.0	70.7	83.0	61.0	80.2		ESE	A.M. Light fog. P.M. Fine—nearly cloudless. Ev. Fine & starlight.
T 16	30.248	30.244	73.5	30.216	30.210	74.0	63	10.0	72.7	81.7	63.4	84.0		ENE	Fine—lt. clouds and wind throughout the day. Ev. Fine & starlight.
W 17	30.186	30.182	73.4	30.104	30.098	74.0	62	05.5	67.0	74.2	61.5	82.5		E	Fine—nearly cloudless—brisk wind throughout the day. Evening, Fine and moonlight.
T 18	30.012	30.006	74.0	29.950	29.946	75.5	68	05.5	73.4	85.3	63.0	74.5		ESE	Fine—light clouds and wind throughout the day. Evening, Lightly overcast—light wind.
F 19	29.996	29.992	74.0	29.972	29.966	74.5	65	06.0	70.4	70.6	67.2	86.0		WSW	Overcast—lt. wind throughout the day. Ev. Moonlight—lt. clouds.
S 20	30.058	30.052	72.0	30.074	30.068	73.0	60	07.0	66.8	69.8	63.0	75.5		WNW v.	Overcast—brisk wind throughout the day. Evening. Fine and moonlight—brisk wind,
●☉ 21	30.058	30.052	70.0	30.014	30.010	72.0	60	06.5	69.8	73.7	62.0	72.2		S	A.M. Heavy clouds—brisk wind. P.M. Fine—light clouds—brisk wind. Evening, Fine—light clouds and wind.
M 22	30.012	30.006	72.0	29.984	29.980	72.0	59	09.0	70.0	77.0	60.5	74.5		NNE	Fine—lt. clouds & wind throughout the day. Ev. Fine & moonlight.
T 23	29.966	29.960	73.0	29.838	29.834	73.0	64	05.0	72.0	75.5	65.0	79.0		S	A.M. Light fog and wind. P.M. Fine—light clouds—brisk wind. Evening, Fine and moonlight.
W 24	29.900	29.896	69.0	29.810	29.804	71.0	56	05.5	62.8	74.0	59.5	80.0		SW	A.M. Thick fog—light wind. P.M. Fine—light clouds and wind. Evening, Overcast—rain, with vivid lightning.
T 25	29.760	29.754	67.0	29.750	29.744	69.0	61	02.0	61.5	69.0	57.5	74.5	.166	NE	Overcast—brisk wind with showers throughout the day. Ev. Overcast—very heavy rain with lightning, with high wind.
F 26	29.890	29.886	69.0	29.884	29.880	70.0	63	05.5	68.0	73.0	61.0	70.5	.369	ENE	A.M. Lightly ovct.—lt. wind. P.M. Fine—lt. clds. & wind. Ev. Same.
S 27	30.008	30.004	67.0	29.980	29.974	69.0	61	04.0	63.0	70.8	60.0	74.0		N	A.M. Overcast—brisk wind. P.M. Fine—lt. clouds—brisk wind. Evening, The same.
☉ 28	30.046	30.040	67.0	30.032	30.026	69.0	61	02.0	62.0	69.5	61.0	71.5	.127	N	A.M. Overcast. P.M. Fine—light clouds and wind. Evening, Fine and starlight.
M 29	30.028	30.022	66.0	29.996	29.992	69.0	63	01.0	63.0	71.0	60.0	70.5	.283	NNE	A.M. Ovct.—lt. wind. P.M. Fine—lt. clds. & wind. Ev. Tremendous heavy rain between 4 and 6 P.M., with lightning & thunder—brisk wind.
T 30	30.076	30.070	66.5	30.048	30.044	68.0	61	02.0	63.0	67.4	60.0	72.0	1.827*	NW	Overcast—lt. wind throughout the day. Ev. The same.
W 31	30.202	30.198	66.0	30.208	30.202	65.0	48	06.5	56.5	61.5	50.0	69.0		N	A.M. Lightly overcast—light wind. P.M. Fine—light clouds and wind. Evening, Lightly overcast.
MEAN.	30.079	30.074	70.3	30.043	30.038	70.9	60	05.7	67.0	73.8	60.8	76.0	Sum. 3.800		Mean Barometer corrected .... 9 A.M. 3 P.M. F. 29.971 .. 29.934 C. 29.965 .. 29.928

The Observations for AUGUST were not taken by the Assistant Secretary on account of absence.

* One of the heaviest showers, within the space of two hours, on the Royal Society's records.

METEOROLOGICAL JOURNAL FOR SEPTEMBER AND OCTOBER, 1842.

1842.	9 o'clock, A.M.			3 o'clock, P.M.			Dew Point at 9 A.M. deg. Fahr.	Diff. of Wet and Dry Bulb Thermometer.	External Thermometers.				Rain in inches. Read off at 9 A.M.	Direction of the Wind at 9 A.M.	REMARKS.
	Barometer uncorrected.		Att. Ther.	Barometer uncorrected.		Att. Ther.			Fahrenheit.		Self-registering				
	Flint Glass.	Crown Glass.		Flint Glass.	Crown Glass.				9 A.M.	3 P.M.	Lowest	Highest			
SEPTEMBER															
T 1	30.034	30.028	62.0	*Omitted*	*Omitted*	*Omit.*	57	00.5	58.5	*Omit.*	55.0	62.0	.166	S	Overcast—light wind and rain throughout the day. Ev. The same.
F 2	30.170	30.162	65.3	30.188	30.180	67.7	64	05.5	68.7	74.2	58.0	70.3	.311	NNW	A.M. Cloudy—light breeze. P.M. Fine—light clouds and breeze. Evening, Fine and starlight.
S 3	30.286	30.278	66.2	30.252	30.244	68.5	63	04.6	62.5	69.2	60.4	76.0		NW	A.M. Overcast—light breeze. P.M. Fine—light clouds. Evening, Fine and starlight.
○⊙ 4	30.274	30.266	65.7	30.262	30.256	68.0	62	05.1	61.3	68.7	57.3	70.6		SW	Ditto ditto ditto.
M 5	30.268	30.260	65.0	30.172	30.164	67.7	61	06.5	63.7	68.8	56.4	70.2		SE	Fine—light clouds and breeze throughout the day. Ev. Fine and starlight.
T 6	30.008	30.000	66.0	29.968	29.960	67.3	60	07.1	64.0	69.3	57.6	71.3		SSE	A.M. Cloudy—light breeze. P.M. Fine—lt. clouds. Evening, Fine and starlight.
W 7	29.928	29.920	68.2	29.776	29.768	67.0	59	06.3	62.0	66.7	54.8	70.8		E	A.M. Fine—lt. clouds. P.M. Cloudy—lt. wind. Ev. Thunder and lightning, accompanied with very heavy rain.
T 8	29.466	29.458	70.0	29.514	29.506	64.7	62	07.8	63.4	56.7	60.3	70.4	.383	S	A.M. Fine—light clouds—high wind, as also high wind throughout the night. P.M. Ovct.—lt. rain—h. wind. Ev. Fine & starlight.
F 9	29.574	29.568	62.0	29.510	29.502	64.8	59	06.0	61.7	63.8	54.6	66.6	.594	S	Overcast—brisk wind throughout the day, with occasional lt. rain. Evening, early part, Overcast; after, Fine and starlight.
S 10	29.458	29.452	68.0	29.550	29.544	64.5	59	06.0	60.7	59.8	56.3	67.4	.022	SW var.	A.M. Fine—lt. clds. & wind. P.M. Cldy. with slt. rain. Ev. The same.
⊙11	29.720	29.714	65.7	29.700	29.696	63.2	57	06.1	59.9	63.8	52.7	65.0	.052	W	Fine—light clouds and wind throughout the day. Ev. Fine & starlight.
M12	29.844	29.836	61.8	29.882	29.874	63.6	57	06.6	60.3	63.8	56.2	65.3		NW	Ditto ditto ditto.
T 13	30.144	30.136	66.0	30.152	30.144	63.9	58	04.4	59.0	63.8	52.4	66.4		N	A.M. Fine—light clouds and wind. P.M. Cloudy—light wind. Evening, Fine and starlight.
W14	30.234	30.226	62.0	30.206	30.198	63.8	59	03.9	62.0	67.8	55.0	66.6		N	Fine—lt. clouds & wind throughout the day. Ev. Fine and moonlight.
T 15	30.216	30.208	62.3	30.154	30.146	64.5	60	03.1	61.5	67.0	57.2	70.0		N	A.M. Cloudy—light fog and wind. P.M. Fine—nearly cloudless. Evening, Fine and moonlight.
F 16	30.150	30.146	61.6	30.076	30.070	63.9	59	04.4	58.3	66.7	54.8	69.3		E	A.M. Light fog & wind. P.M. Cloudy—light wind. Ev. The same.
S 17	29.852	29.846	66.3	29.790	29.782	64.8	60	06.3	65.7	68.7	56.2	68.3		E	Fine—light clouds & wind throughout the day. Ev. Overcast—lt. rain.
⊙18	29.810	29.802	62.0	29.750	29.744	63.0	59	04.7	56.5	58.0	54.4	71.0	.261	N	Overcast—light rain and wind throughout the day. Ev. The same.
●M19	29.644	29.638	61.7	29.628	29.620	63.0	59	05.5	61.0	60.3	52.4	65.4	.205	S	A.M. Fine—light clouds and wind. P.M. Dark heavy clouds—brisk wind—light rain. Evening, Fine and moonlight.
T 20	29.570	29.564	63.0	29.534	29.526	61.7	55	05.8	58.7	56.3	50.6	65.4	.033	SW	A.M. Fine—light clouds and wind. P.M. Cloudy, with occasional slight rain. Evening, Fine and moonlight.
W21	29.534	29.526	62.0	29.540	29.534	61.3	54	04.5	57.7	60.2	49.7	64.3	.063	SSW	A.M. Fine—light clouds and wind. P.M. Cloudy—slight rain and wind. Evening, Fine and moonlight.
T 22	29.528	29.520	57.2	29.496	29.488	59.2	52	03.3	49.8	57.7	44.4	62.2		W	A.M. Overcast—light wind. P.M. Fine—lt. clds. & wind. Ev.Ovct.
F 23	29.534	29.526	58.4	29.480	29.472	58.0	51	03.7	52.3	54.7	46.7	59.7		S	Overcast—lt. rain & wind nearly the whole of the day. Ev.The same.
S 24	29.400	29.392	57.0	29.426	29.413	57.2	53	04.1	52.4	54.3	48.6	58.4	.630	E	A.M. Dark heavy clouds—lt. wind. P.M. Ovct—slt. rain. Ev. Ditto.
⊙25	29.580	29.572	56.4	29.616	29.610	58.5	54	03.0	55.7	61.0	46.6	57.3	.111	N	A.M. Light fog and wind. P.M. Fine—light clouds and wind. Evening, Overcast—light rain.
M26	29.866	29.858	58.0	29.902	29.896	59.2	55	03.2	57.0	59.3	52.6	62.7	.338	N	A.M. Fine—lt. clouds & wind—heavy shower early. P.M. Cloudy—lt. wind. Evening, Dark heavy clouds—moon very bright.
T 27	29.934	29.926	55.6	29.896	29.890	55.9	50	03.3	52.2	51.7	50.5	62.0	.088	NNE	Overcast—light rain—brisk wind nearly throughout the day. Ev. Overcast—brisk wind.
W28	30.110	30.102	56.0	30.098	30.090	56.3	50	03.9	52.7	55.7	50.0	54.8	.288	N	A.M. Overcast—brisk wind. P.M. Fine—lt. clds,—brisk wind. Ev. Moonlight—dark clouds.
T 29	30.080	30.072	55.2	30.086	30.078	55.8	49	05.0	53.5	53.5	49.6	58.7		NE var.	A.M. Fine—light clouds—brisk wind. P.M. Cloudy—brisk wind—slight rain. Evening, Cloudy.
F 30	30.208	30.200	54.4	30.184	30.176	54.5	47	05.6	52.3	53.5	47.5	59.3		NE	A.M. Cloudy—brisk wind. P.M. Fine—nearly cloudless. Ev. Overcast—slight rain.
MEAN.	29.881	29.873	62.0	29.855	29.849	66.3	57	04.9	58.8	61.9	53.5	65.6	Sum. 3.545	Mean Barometer corrected	9 A.M. 3 P.M. F. 29.796 .. 29.759 C. 29.787 .. 29.752
OCTOBER															
S 1	30.268	30.262	54.0	30.280	30.272	55.0	48	03.7	50.7	58.0	46.8	56.5		NW	A.M. Fine—light clouds and wind. P.M. Cloudy—light wind. Evening, Overcast—light fog.
⊙ 2	30.336	30.328	52.0	30.252	30.246	53.5	46	03.1	46.2	55.2	42.8	57.6		NNW	A.M. Light fog and wind. P.M. Slightly overcast—light wind. Evening, Fine and starlight.
M 3	30.106	30.098	51.5	30.042	30.034	54.2	47	03.6	50.2	57.7	45.8	56.7		NNW	A.M. Light fog & wind. P.M. Cloudy—light wind. Ev.Overcast.
○T 4	30.096	30.092	52.5	30.098	30:092	53.7	46	04.7	50:3	54.3	45.2	59.4		NNW	A.M. Fine—light clouds and wind—light fog early. P.M. Cloudy—light wind. Evening, Fine and starlight.
W 5	30.236	30.228	50.0	30.230	30.222	51.3	43	02.7	43.3	51.8	42.3	56.0		NNW	A.M. Light fog & wind. P.M. Fine—nearly cloudless. Evening, Starlight—light fog.
T 6	30.334	30.326	49.8	30.302	30.294	52.3	42	03.5	46.0	57.2	42.7	48.3		NW	A.M. Light fog & wind. P.M. Cloudy—lt. wind. Ev. Light fog—few stars.
F 7	30.314	30.306	52.3	30.284	30.276	53.7	47	04.3	51.4	58.8	46.8	59.3		W	A.M. Fine—light clouds and wind. P.M. Cloudy—light wind. Evening, Fine and starlight.
S 8	30.416	30.408	54.3	30.440	30.432	55.6	50	03.0	53.9	57.7	51.0	60.7		N	A.M. Fine—light clouds and wind. P.M. Cloudy—slight rain and wind. Evening. The same.
⊙ 9	30.540	30.532	53.3	30.500	30.494	55.0	48	02.0	51.3	56.5	48.5	50.2		N	Overcast—light wind throughout the day. Evening, The same.
M10	30.510	30.502	54.0	30.468	30.460	55.0	48	04.6	53.7	55.2	51.0	58.2		N	Cloudy—light wind throughout the day. Ev. Fine and starlight.
T 11	30.410	30.402	53.2	30.346	30.338	54.3	46	02.5	47.8	57.8	46.3	56.3		NNW	Fine—light clouds and fog throughout the day. Ev. Fine & starlight.
W12	30.332	30.324	54.6	30.278	30.270	55.7	49	03.4	52.4	54.7	48.3	59.6		NNW	A.M. Fine—nearly cloudless—light wind. P.M. Cloudy—light wind. Evening, Overcast—very slight rain.
T 13	30.302	30.296	53.7	30.282	30.274	55.0	48	04.2	51.7	54.7	49.2	58.3		N	Overcast—light wind throughout the day. Ev. Overcast—light fog.
F 14	30.252	30.246	52.2	30.244	30.236	53.3	47	04.0	48.8	53.4	45.9	56.3		NNW	A.M. Light fog and wind. P.M. Overcast—lt. fog. Ev. The same.
S 15	30.312	30.304	52.7	30.286	30.282	53.5	49	02.6	51.0	54.6	49.5	54.7		W	A.M. Thick fog—lt. wind. P.M. Overcast—light wind. Evening, The same—light fog.
⊙16	30.288	30.282	53.2	30.234	30.230	54.6	48	03.5	51.7	55.8	51.3	55.8		W	Overcast—light fog and wind throughout the day. Ev. Light fog.
M17	30.070	30.062	53.0	29.910	29.902	53.8	51	03.3	51.7	52.7	51.0	57.6		NNW	Foggy throughout the day, as also the evening.
T 18	29.482	29.476	53.3	29.334	29.328	54.2	48	04.3	52.0	53.0	49.6	54.2		S	A.M. Fine—light clouds and wind. P.M. Cloudy—slight rain and wind. Evening, Overcast—light rain.
●W19	29.280	29.272	50.0	29.428	29.420	51.0	42	02.5	42.3	47.7	40.8	57.8	.488	W	A.M. Overcast—light wind. P.M. Fine—light clouds and wind. Evening, Fine and moonlight.
T 20	29.672	29.664	45.6	29.686	29.678	47.0	38	03.0	37.3	45.0	36.6	48.2		W	Fine—nearly cloudless—light wind throughout the day. Ev. Fine and moonlight.
F 21	29.912	29.904	43.8	29.948	29.940	44.8	33	03.5	38.0	44.8	34.3	47.0		NW	Fine—lt. clouds & wind throughout the day. Ev. Fine & starlight.
S 22	29.700	29.692	41.9	29.238	29.230	43.5	36	03.4	40.0	46.3	32.7	45.7		S	A.M. Overcast—light wind. P.M. Overcast—light rain—high wind. Evening, The same.
⊙23	28.792	28.788	44.3	28.818	28.814	46.0	40	01.5	44.7	47.0	39.7	48.8	.444	S	A.M. Fine—lt. clouds & wind—rain early. P.M. Ovct.—lt. shower. Ev. Overcast.
M24	29.194	29.186	44.0	29.390	29.384	45.7	39	02.8	42.3	45.3	37.5	50.6		W	A.M. Overcast—light fog and wind—slight rain. P.M. Cloudy—light wind. Evening, Fine and moonlight.
T 25	29.634	29.626	42.4	29.486	29.480	44.3	37	03.4	41.3	46.5	35.7	46.7	.013	SSE	Overcast—light rain—fog and wind nearly the whole of the day. Evening, The same.
W26	29.590	29.582	43.0	29.634	29.626	54.5	38	03.3	37.8	44.0	34.0	49.0	.344	S	A.M. Fine—light clouds & wind—high wind throughout the night. P.M. Fine—lt. clouds. Ev. Fine and starlight.
T 27	29.700	29.692	43.0	29.712	29.704	45.0	38	02.2	42.4	49.4	38.3	45.3		S	A.M. Fine—lt. clds. & wind. P.M. Fine—lt. clouds—slight rain. Ev. Lt. fog.
F 28	29.552	29.546	44.0	29.636	29.630	45.9	39	01.6	40.5	48.8	40.0	51.0		W	Fine—lt. clouds & wind throughout the day. Ev. Starlight—lt. fog.
S 29	29.806	29.798	43.0	29.866	29.858	44.8	36	01.6	37.3	47.8	35.2	50.6		SSW	Fine—lt. clouds & fog throughout the day. Ev. Starlight—lt. fog.
⊙30	30.116	30.108	42.8	30.150	30:144	44.0	36	01.7	37.4	48.0	34.8	49.0		SW	Fine—light clouds throughout the day—fog early. Evening, Starlight—light fog.
M31	30.268	30.260	45.0	30.262	30.254	47.3	40	03.1	47.7	51.8	37.6	49.7		S	A.M. Light fog & wind. P.M. Overcast. Evening, Fine & starlight.
MEAN.	29.994	29.987	49.1	29.970	29.963	50.9	43	03.1	46.2	52.0	42.9	53.4	Sum. 1.289	Mean Barometer corrected	9 A.M. 3 P.M. F. 29.943 .. 29.914 C. 29.935 .. 29.906

METEOROLOGICAL JOURNAL FOR NOVEMBER AND DECEMBER, 1842.

1842.	9 o'clock, A.M.			3 o'clock, P.M.			Dew Point at 9 A.M., deg. Fahr.	Diff. of Wet and Dry Bulb Ther.	External Thermometers.				Rain in inches. Read off at 9 A.M.	Direction of the Wind at 9 A.M.	REMARKS.
	Barometer uncorrected.		Att. Ther.	Barometer uncorrected.		Att. Ther.			Fahrenheit.		Self-registering				
	Flint Glass.	Crown Glass.		Flint Glass.	Crown Glass.				9 A.M.	3 P.M.	Lowest	Highest			
NOVEMBER															
T 1	30.234	30.226	47.0	30.172	30.164	47.8	43	01.7	44.9	51.3	43.2	53.4		SSW	A.M. Fine—light clouds and wind. P.M. Fine—nearly cloudless. Evening, Light fog.
○ W 2	30.140	30.132	47.4	30.096	30.088	48.8	45	01.3	48.3	50.8	43.8	52.6		E	Overcast—deposition—light wind throughout the day. Evening, Fine and starlight—light fog.
T 3	30.000	29.994	46.7	29.956	29.948	47.7	42	02.2	43.3	47.4	42.0	52.0		N	A.M. Overcast—brisk wind. P.M. Cloudy—lt. wind. Ev. Overcast —slight rain.
F 4	30.060	30.052	44.8	30.126	30.120	45.0	38	01.8	39.5	38.8	37.8	49.0		NNW	A.M. Fine—light clouds and wind. P.M. Cloudy—light rain and snow. Evening, Cloudy—light fog.
S 5	30.190	30.182	43.0	30.120	30.112	44.4	37	03.5	42.0	45.4	37.4	43.4	.033	N	A.M. Fine—light clouds and wind—light rain early. P.M. Cloudy—light wind. Evening, Overcast—very slight rain.
☉ 6	30.202	30.194	41.8	30.158	30.150	43 0	36	02.2	38.3	42.3	36.7	46.8		N	Cloudy—lt. wind throughout the day. Ev. The same, with light fog.
M 7	30.130	30.122	42.7	30.128	30.120	44.6	39	02.7	42.3	45.6	38.4	43.6		NW	A.M. Cloudy—brisk wind—slight rain early. P.M. Cloudy—brisk wind—slight rain. Evening, Light fog.
T 8	30.152	30.144	43.6	30.078	30.070	44.4	39	02.3	42.3	44.3	40.6	48.2		NW	Cloudy—brisk wind throughout the day. Ev. Overcast—light fog.
W 9	29.806	29.798	44.0	29.700	29.692	45 2	37	03.8	43.7	45.5	41.8	45.7		S	Cloudy—high wind throughout the day. Ev. Ovct.—lt. rain—h. wind.
T 10	29.684	29.676	46.6	29.636	29.628	48.0	45	01.7	48.4	49.7	44.0	49.8	.038	S	Overcast—brisk wind throughout the day—very high wind throughout the night. Evening, The like.
F 11	29.180	29.172	47.2	29.002	28.998	49.4	45	02.8	50.7	51.7	43.2	52.3	.019	S	A.M. Cloudy—high wind—light rain early—very high wind throughout the night. P.M. Ovct.—lt. rain—high wind. Ev. Overcast.
S 12	29.122	29.116	50.6	29.332	29.326	51.6	48	01.6	51.5	53.8	49.5	55.0	.261	W	A.M. Cloudy—high wind—light rain—very high wind throughout the night. P.M. Cloudy—high wind. Ev. Fine and starlight.
☉ 13	29.512	29.506	50.6	29.256	29.248	51.3	47	01.9	50.0	52.3	48.0	55.5	.494	SSE	Ovct.—lt. rain—high wind nearly the whole of the day. Ev. The same.
M 14	29.720	29.714	50.6	29.804	29.798	51.3	47	02.2	47.7	47.7	46.7	55.0	.266	W	A.M. Light fog and wind. P.M. Fine—light clouds. Ev. Overcast—light rain—high wind.
T 15	29.686	29.680	48.8	29.618	29.612	48.3	45	00.2	43.3	44.5	43.7	51.6	.625	E	Overcast—rain, with lt. wind nearly the whole day. Ev. The same.
W 16	29.762	29.754	47.8	29.790	29.782	47.7	43	00.6	44.0	44.3	43.6	47.0	.355	NE	Overcast—high wind, with occasional rain throughout the day. Evening, Fine and starlight.
T 17	30.232	30.224	44.0	30.360	30.352	44.6	37	03.5	40.7	43.7	39.2	45.3	.033	NNE	Ovct.—brisk wind throughout the day. Ev. Moonlight—lt. clouds.
● F 18	30.582	30.574	44.2	30.532	30.526	45.0	37	03.7	41.3	43.3	40.2	45.0		E	A.M. Light fog and wind. P.M. Fine—light clouds. Evening, Fine and moonlight—light clouds.
S 19	30.232	30.224	43.3	30.060	30.052	44.7	41	04.0	43.8	47.3	38.4	45.3		S	A.M. Overcast—very slight rain—high wind. P.M. Overcast—light wind. Evening, Overcast—light rain and wind.
☉ 20	29.788	29.780	47.2	29.774	29.768	48.0	44	02.4	46.7	47.0	37.8	52.8	.677	N	Overcast—brisk wind throughout the day. Ev. The same—lt. fog.
M 21	29.800	29.794	44.8	29.824	29.816	45.2	38	02.5	40.3	43.7	40.3	49.6		N	Fine—lt. clouds and wind throughout the day. Ev. Overcast—lt. fog.
T 22	29.420	29.412	42.9	29.284	29.278	42.7	37	01.2	35.7	37.0	36.4	45.3	.244	SE	Overcast—light wind, rain, and snow nearly the whole of the day. Evening, Fine and starlight.
W 23	29.496	29.488	41.0	29.590	29.584	42.4	37	01.4	38.4	43.7	35.6	39.4	.177	S	A.M. Fine—lt. clouds & wind. P.M. Cloudy—lt. rain. Ev. Ovct.—light rain and wind.
T 24	28.908	28.900	43.6	28.916	28.908	45.2	40	02.0	43.7	47.0	38.7	46.3	.105	S	A.M. Fine—light clouds and wind. P.M. The same, with light shower. Evening, Overcast—heavy rain—high wind.
F 25	28.900	28.896	45.0	28.878	28.872	46.0	42	02.5	44.2	46.3	42.8	48.2	.300	S var.	A.M. Cloudy—light rain—very high wind, as also throughout the night. P.M. Fine—lt. clouds & wind. Ev. Overcast—brisk wind.
S 26	29.094	29.088	44.5	29.170	29.164	45.6	40	03.2	43.4	47.6	41.3	47.6	.105	SSE	Fine—lt. clouds & wind throughout the day. Ev. Fine & starlight.
☉ 27	29.366	29.358	44.2	29.314	29.306	45.0	40	01.8	42.7	45.8	40.2	49.0		S	A.M. Overcast—slight rain and wind. P.M. Fine—light clouds and wind. Evening, Light fog and rain.
M 28	28.944	28.938	46.3	28.892	28.886	48.3	45	02.7	49.3	52.3	43.0	50.8	.222	SE	A.M. Fine—light clouds and wind—light rain early. P.M. Cloudy—light wind. Evening, Fine and starlight.
T 29	29.540	29.532	47.0	29.546	29.540	48.0	42	01.9	44.4	48.4	44.2	54.3	.061	SE	Fine—light clouds and wind nearly the whole of the day. Evening, Overcast—light fog.
W 30	29.662	29.654	47.2	29.860	29.852	48.0	44	01.3	46.2	47.3	44.6	51.2	.033	W	A.M. Light fog—rain early. P.M. Fine—lt. clouds. Ev. Light fog.
MEAN.	29.718	29.711	45.6	29.699	29.692	46.6	41	02.3	44.0	46.5	41.4	49.0	Sum. 4.048		Mean Barometer corrected .... 9 A.M. 3 P.M. F. 29.676 .. 29.655 C. 29.668 .. 29.647
DECEMBER															
T 1	30.062	30.054	47.8	30.036	30.030	49.5	46	01.3	49.7	51.5	43.3	51.0		SE	A.M. Cloudy—very slight rain—brisk wind. P.M. Overcast—brisk wind. Evening, The same.
○ F 2	30.110	30.102	51.6	30.108	30.100	52.9	49	02.2	52.0	54.3	49.8	55.0		SSE	A.M. Overcast—very slight rain—brisk wind—high wind throughout the night. P.M. Cloudy. Evening, Fine and starlight.
S 3	30.252	30.246	50.0	30.318	30.310	51.0	46	02.0	46.7	52.8	45.5	56.3		S	A.M. Fine—light clouds and wind. P.M. Cloudy—deposition—light wind. Evening, Thick fog.
☉ 4	30.454	30.446	50.0	30.406	30.398	51.0	47	01.3	47.7	50.7	44.4	54.7		W	A.M. Lt. fog & wind. P.M. Cloudy—lt. wind. Ev. Lt. fog & wind.
M 5	30.344	30.336	49.4	30.286	30.280	50.2	44	01.5	44.7	49.3	44.6	52.6		SSW	A.M. Lightly ovct.—lt. wind. P.M. Cldy.—lt. wind. Ev. Thick fog.
T 6	30.264	30.256	47.8	30.226	30.218	47.4	43	01.3	41.3	41.3	40.8	50.6		SSE	A.M. Overcast—deposition—lt. fog. P.M. Thick fog. Ev. The same.
W 7	30.350	30.342	45.2	30.352	30.344	45.0	38	01.6	39.5	40.3	37.8	42.8		W	Light fog and wind throughout the day. Evening, The same.
T 8	30.442	30.434	43.6	30.422	30.416	43.7	39	01.4	37.3	39.8	36.0	41.6		W	Thick fog—light wind nearly the whole of the day. Evening, Starlight—light fog.
F 9	30.424	30.418	43.8	30.372	30.364	44.6	40	02.1	41.7	43.7	36.6	43.2		W	A.M. Light fog and wind. P.M. Overcast—lt. wind. Ev. Light fog.
S 10	30.256	30.250	43.8	30.212	30.204	43.6	38	02.1	37.8	38.8	37.5	45.0		SE	Cloudy—light wind throughout the day. Evening, Lightly overcast.
☉ 11	30.026	30.018	42.3	29.956	29.950	43.0	38	01.0	38.7	42.4	37.3	40.8		E	Overcast—lt. wind throughout the day. Ev. Overcast—slight rain.
M 12	29.820	29.814	45.0	29.906	29.900	48.2	43	02.4	50.3	54.4	38.8	51.5	.269	SE	Overcast—slight rain—brisk wind nearly the whole of the day. Evening, Overcast.
T 13	30.076	30.070	51.3	30.066	30.058	52.0	48	02.0	51.6	54.8	38.8	56.5		SE	A.M. Fine—light clouds. P.M. Fine—nearly cloudless—light wind. Evening, Fine and starlight—light clouds.
W 14	30.144	30.136	51.3	30.134	30.126	52.0	48	01.4	49.8	53.7	49.2	57.5		S	A.M. Lightly overcast—light wind. P.M. Fine—light clouds. Evening, Fine and starlight.
T 15	30.164	30.156	50.2	30.160	30.152	51.5	46	02.3	48.3	52.8	46.8	55.0		S	Fine—light clouds and wind throughout the day. Evening, Cloudy.
F 16	30.090	30.082	51.3	30.014	30.006	52.3	48	02.6	50.0	53.8	47.7	54.6		S	Overcast—light wind throughout the day. Ev. Cloudy—slight rain.
● S 17	30.002	29.994	52.3	30.110	30.102	52.6	48	02.5	50.5	48.4	50.2	55.6	.050	SSW	Fine—light clouds and wind throughout the day. Evening, Fine and moonlight—light clouds.
☉ 18	30.314	30.306	47.8	30.332	30.328	48.0	42	01.2	39.4	46.3	39.3	52.6		S	Fine—light clouds and wind throughout the day. Evening, Fine and moonlight.
M 19	30.518	30.512	45.6	30.514	30.506	46.0	40	00.8	39.3	44.3	39.0	46.0		W	A.M. Overcast—light fog. P.M. Fine—light clouds. Ev. Cloudy.
T 20	30.430	30.422	45.3	30.400	30.392	46.6	43	01.4	45.7	50.2	39.0	46.4		S	Overcast—deposition—lt. wind throughout the day. Ev. The same.
W 21	30.328	30.320	49.3	30.320	30.312	50.5	46	00.8	51.3	53.0	39.0	51.4		W	Overcast—lt. wind throughout the day. Ev. Overcast—deposition.
T 22	30.194	30.186	51.5	30.068	30.060	51.8	46	01.2	50.2	51.7	49.0	56.3		S	A.M. Fine—light clouds and wind. P.M. Fine—nearly cloudless. Evening, Overcast.
F 23	29.636	29.630	51.3	29.586	29.580	51.3	48	01.5	47.4	46.4	47.6	53.8	.075	S	A.M. Overcast—slight rain. P.M. Overcast—deposition. Ev. Fine and starlight.
S 24	29.696	29.690	45 8	29.722	29.714	45.7	39	01.6	36.7	41.7	36.2	47.4	.097	S	A.M. Fine—nearly cloudless—light wind and frost. P.M. Fine—nearly cloudless. Evening, Fine and starlight.
☉ 25	29.848	29.842	42.0	29.742	29.738	44.0	37	01.7	36.7	46.3	35.0	42.4		S	A.M. Fine—nearly cloudless—light wind and frost. P.M. Overcast—lt. wind. Ev. Overcast—very fine rain—high wind.
M 26	29.566	29.560	46.7	29.428	29.422	48.0	45	02.0	48.8	48.7	37.3	50.3	.022	S var.	A.M. Overcast—high wind, as also during the night. P.M. The same, with slight rain. Evening, The same.
T 27	29.364	29.356	47.5	29.482	29.476	48.0	43	01.6	43.7	45.7	44.0	50.6	.161	S	A.M. Ovct.—lt. rain & wind. P.M. Fine—lt. clds. Ev. Starlight—lt. fog.
W 28	30.030	30.024	42 8	30.126	30.118	43.0	36	01.4	35.0	41.3	34.7	47.0		W	A.M. Fine—light clouds—fog and wind. P.M. Fine—nearly cloudless. Evening, Fine and starlight.
T 29	30.152	30.146	43.0	30.152	30.144	44.7	42	02.2	47.0	50.7	35.4	48.2		SW	Overcast—light brisk wind nearly the whole of the day; early part, very slight rain. Evening, Overcast.
F 30	30.222	30.216	47.4	30.212	30.206	49.4	45	02.5	52.3	54.3	47 2	53.3		S var.	Cloudy—light wind throughout the day. Evening, Overcast.
○ S 31	30.144	30.140	50.3	30.046	30.040	51.3	47	01.9	51.3	54.3	50.6	55.4		S var.	Cloudy—brisk wind throughout the day. Evening, Early part, slight rain; after, fine and starlight.
MEAN.	30.120	30.113	47.5	30.103	30.097	48.4	44	01.7	45.2	48.3	41.9	50.5	Sum. .674		Mean Barometer corrected .... 9 A.M. 3 P.M. F. 30.073 .. 30.053 C. 30.065 .. 30.047